Section 5
Impact Assessment and Management

Preamble

This section commences with the presentation of relevant background information about a range of environmental features within and surrounding the Project Site. These features, whilst not directly affected by the Project, may have some influence on a number of other environmental issues addressed throughout the remainder of this section.

This section presents information on the existing conditions, proposed safeguards and controls and potential impacts upon various environmental components of the local environment within and surrounding the Project Site. Where appropriate, proposed monitoring programs are also described.

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5.1 Background Information

5.1.1 Topography

The Project Site lies within the western end of the Namoi River Basin where the regional topography is characterised by generally flat terrain with higher country approximately 45km to the northeast in the Mount Kaputar National Park and approximately 20km to the south in the Pilliga East State Forest. (R.W. Corkery, 2002).

Natural Slopes within the region range from less than 1° on the flat terrain and flood plains of the Namoi River to in excess of 30° within the Mount Kaputar National Park (R.W. Corkery, 2002).

Elevations in the region range from 1 510m at Mount Kaputar and approximately 220m within the flat, open terrain between the forest edge and the Namoi River flood plains.

Elevations around the Bibblewindi CSG Pilot are typically around 280m AHD whilst those around the Bohena CSG Pilot are about 260m AHD. The Wilga Park Power Station is located approximately 0.5km west of Bohena Creek where the elevation is approximately 222m AHD.

5.1.2 Geology

Geologically, the Project Site is located within the northern portion of the Permo-Triassic Gunnedah Basin, which forms the central part of the much larger Sydney-Gunnedah-Bowen Basin system. Jurassic and Cretaceous sediments of the Surat Basin sequence unconformably overlie the Gunnedah Basin sequence and outcrop over all except the easternmost areas of PEL 238 where Triassic, Permian and basement outcrops.

The Gunnedah Basin covers an area of more than 15 000 km^2 and is bound to the east by the Hunter-Mooki Thrust Fault System and the New England Fold Belt, and to the west by the Lachlan Fold Belt where sediments gradually onlap. To the south, the basin is arbitrarily bound by the Mt. Coricudgy Anticline and to the north by the Bellata High, where the Permo-Triassic sequence thins over basement.

The primary CSG target coal seams in the Early Permian Maules Creek Formation are located in a north-south trending, longitudinal depositional centre in the central and eastern portions of PEL 238 within the Bohena Sub-basin. In this sub-basin, the coals lie at depths ranging from 560m to 1000m and do not outcrop.

5.1.3 Meteorology

The following summaries of meteorological information have been derived from long term data collected by the Bureau of Meteorology at the Narrabri Bowling Club Automatic Weather Station 054120.

5.1.3.1 Temperature

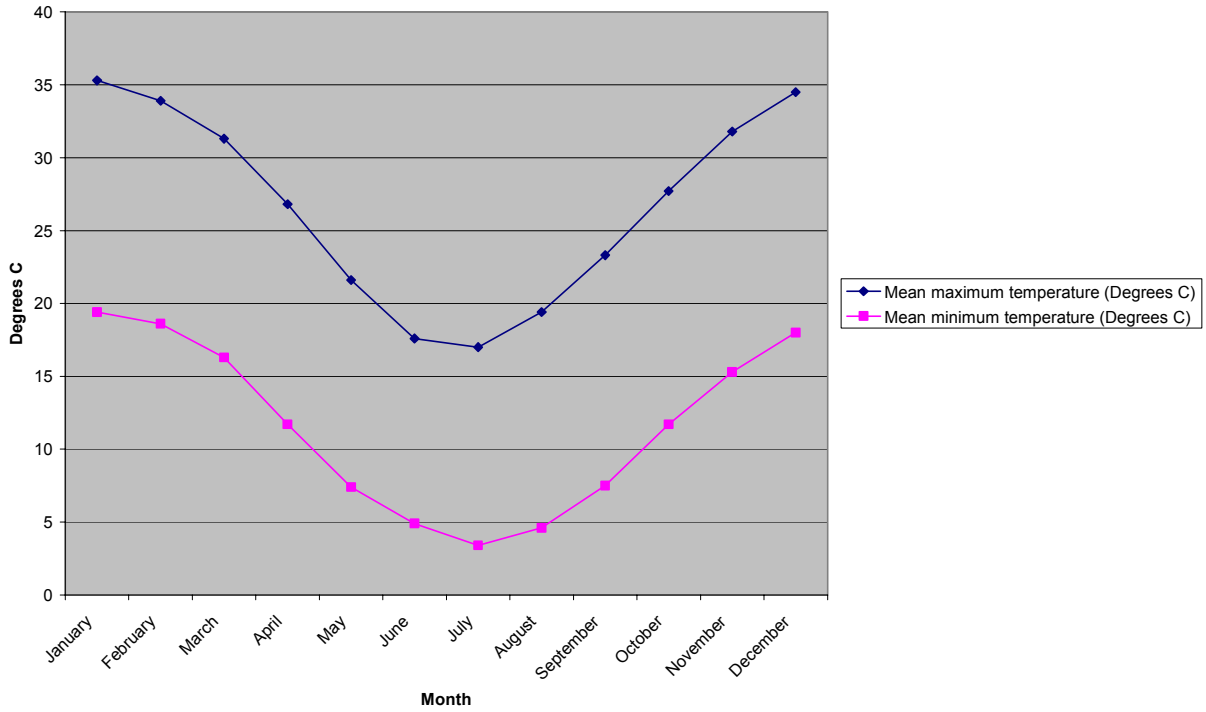


Figure 5.1
Temperature

Average daily maximum and minimum temperatures recorded in Narrabri are represented graphically in **Figure 5.1**. December, January and February are the warmest months with mean daily maximum temperatures of between 33.9°C and 35.3°C. June, July and August are the coolest months of the year on average with mean daily minimum temperature of between 3.4°C and 4.9°C.

5.1.3.2 Rainfall

Mean annual rainfall distribution in the Narrabri area is graphically presented in figure X. The average annual rainfall at the Narrabri Bowling Club AWS is 643.2mm and is derived from 130 years of data. Highest monthly rainfall s occur during January and February with the lowest rainfalls generally experienced in April, August and September.

5.1.3.3 Relative Humidity

The relative humidity in the Narrabri region is typical of a warm temperate climate (Corkery, 2002). The current available data set for relative humidity at the Narrabri Bowling Club AWS is incomplete, however, Heggies (2007) – Appendix 5 state that the mean 9am and 3pm relative humidity is 63% and 50% respectively with higher relative humidity observations throughout the winter months.

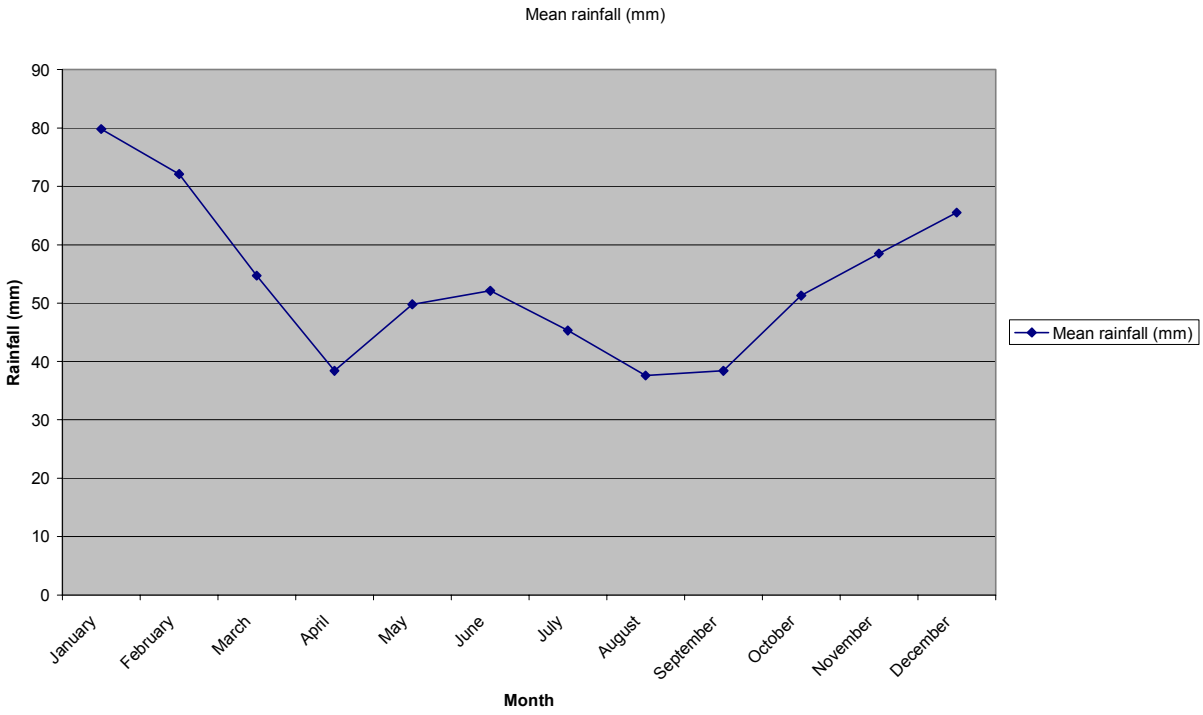


Figure 5.2
Rainfall

5.1.3.4 Wind

Figure 5.3 displays seasonal wind roses prepared from Narrabri data collected over a 5 year period.

5.1.4 Land Ownership and Land Use

5.1.4.1 Land Titles and Ownership

Figure 5.4 displays the land title data for the land adjoining the gas flow line corridor between the Bibblewindi CSG Pilot and the Wilga Park Power Station.

Figure 5.5 presents the ownership details of the land adjacent to the gas flow line corridor. Land ownership along the corridor route is of two main types, namely State Forests Crown Lands under the control of the NSW Department of Primary Industries (Forests NSW) and lands under freehold/leasehold ownership. The gas flow line corridor also intersects a highway easement and a number of Narrabri Shire roads between the East Pilliga State Forest and the Wilga Park Power Station.

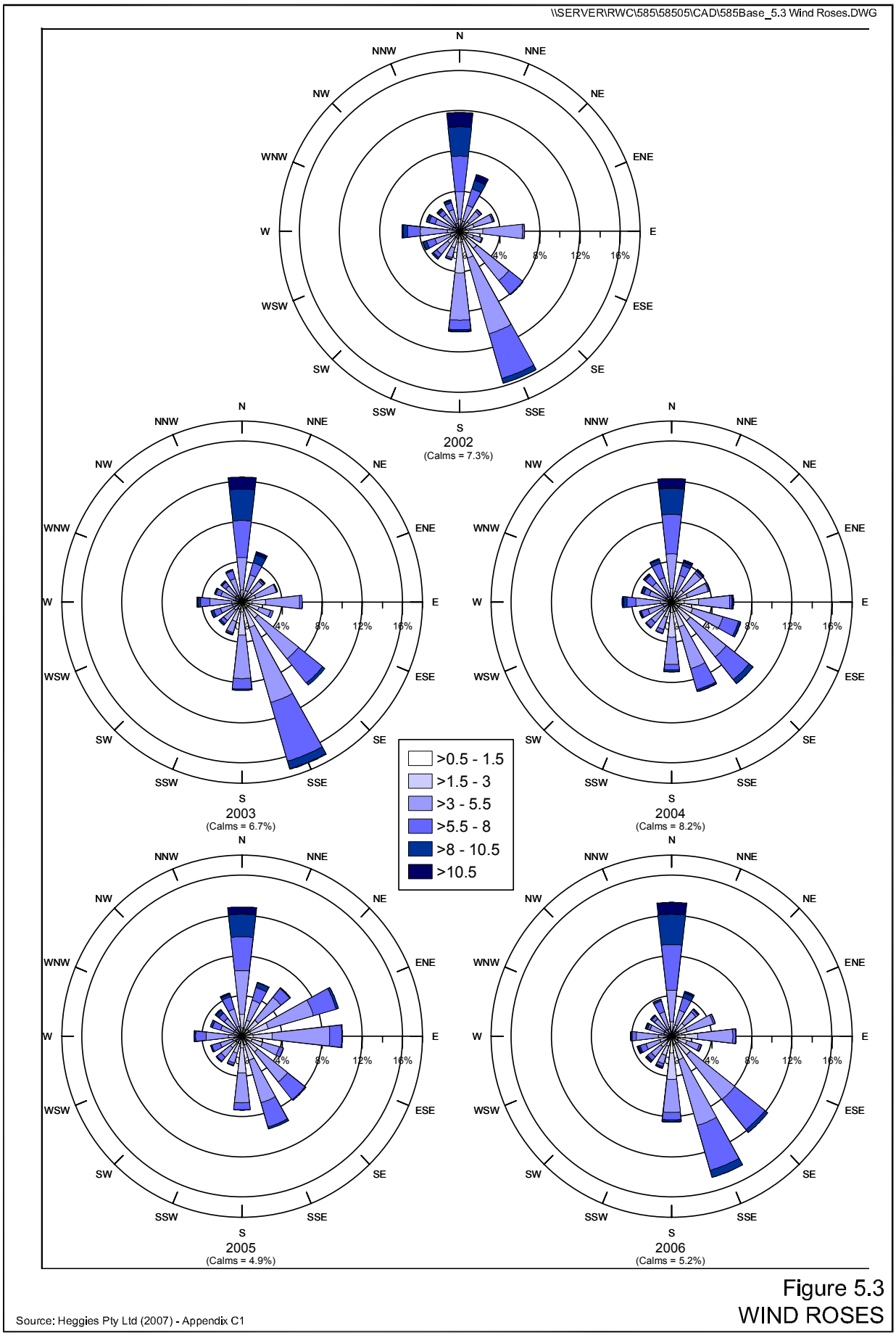


Figure 5.3
WIND ROSES

Source: Heggies Pty Ltd (2007) - Appendix C1

Figure 5.4
LAND TITLE DATA
GAS FLOW LINE CORRIDOR

\\SERVER\RWC\585\Reports\58505\CAD\585Base_.DWG

TN
MN

Wilga Park Power Station
"Moorabbin"
"Woodend"
"Tintsfield"
"Linden"
"Wilga Park"
"Taradale"
"Brigalow Park"
"Nuable Creek"
J. Nehrkorn
"Merlville"
"Lilydale"
"Tralee"
"Marooma"
B.J. Gosper
"Clarendon"
"Wilga View"
"Yallambee"
"Rosewood Farm"
M.L. & D.P. Pringle
"Glenwood"
"Albion Park"
G.B. Pringle
"Woorabinda"

See Detail Left
See Detail Right

"Woorabinda"
Dog Fence Road
Pilliga East State Forest
Bohena CSG Pilot and Gas Gathering System
"Burrawarna Park"
Bibblewindi State Forest
Bibblewindi CSG Pilot and Gas Gathering System

REFERENCE	LANDOWNER
1	Narrabri Power Limited
2	R.G. Archer
3	J.D. Williams
4	B.W. Cain
5	C.B. & A.M Cain
6	B.F. McNamara
7	J. Nehrkorn
8	M.C. Houguet
9	E.R. Hodges
10	A.L. McNamara
11	G.M. & T. Hewitt
12	L.E. Hodges
13	B.J. Gosper
14	T.W. & E.M. Smith
15	K.& A. Knight
16	M.J. & H.J. Gosper
17	M.P. & G.K. Davis
18	H.M, J.M, P.L & A.P. Kelle
19	K.C. & J.L. Todkill
20	R.K. & M.M. Clark
21	M.L. & D.P. Pringle
22	B.F. & J.M. McNamara
23	A.L. McNamara
24	G.B. Pringle
25	N. Ashe
26	J.G. Pringle
27	W.E. Walker

REFERENCE
Project Site Boundary
Proposed Gas Flow Line Corridor
Cadastral Boundary
Residence

SCALE 1:75 000

1 0 1 2 3 4km

Base Photo Source: NSW Dept. of Lands - Date of Photo: 11/10/2006

Figure 5.5
LAND OWNERSHIP
GAS FLOW LINE CORRIDOR

5.1.4.2 Land Use

The proposed gas flow line corridor between the Bibblewindi CSG Pilot and the Wilga Park Power Station traverses two land use classifications, namely approximately 14 km within lands designated Crown Lands State Forest under the *Forestry Act 1916* and 18 km within lands designated Zone 1a (General Rural) under the *Narrabri Local Environment Plan 1992*. The distinction between these land use zones is clearly defined on **Figure 5.4**.

Forestry NSW Land

The *Brigalow and Nandewar Community Conservation Area Act 2005* redefined the land classification for the Pilliga State Forests system. The objects of this Act are to reserve forested land in the Brigalow and Nandewar area for the maintenance of a Community Conservation Area that provides for permanent conservation of land, protection of areas of natural and cultural heritage significance to Aboriginal people and sustainable forestry, mining and other appropriate uses. The creation of a zone for community conservation area, within which the southern portion of the Project Site is situated, permits the continued exploration for and assessment of petroleum resources.

In assessing the suitability of the proposed gas flow line corridor with respect to present and future land use conflicts, consultation with DPI (Forestry NSW) has occurred at various stages during planning. In issuing the Proponent with an occupation permit, the proposed routes, construction specifications and safety management plans would be assessed in terms of any potential impacts on current and future commercial logging operations.

Open Freehold Land

Preliminary route selection focused on the placement of the flow line as close as practicable to existing fence lines, property boundaries, power line easements and uncleared shelter belts/road easements where impacts on present land uses can be minimised to the greatest extent.

A key feature of private landholder negotiations has been the focus on implementing the proposal with minimal disruption to present land uses, impacts on existing farming infrastructure and integrating with seasonal agricultural production planning. Contained within each landholder easement agreement are stated conditions of entry, operation and compensation as defined by each individual title holder/s and each generally reflects the focus on impact minimisation.

The construction specifications of the flow line furthermore mitigate the risks of impacting on future land use practices. With a minimum 750mm of earth covering the flow line once the trench has been backfilled, agricultural production activities such as cropping and grazing can recommence immediately. The limitations to ongoing activities within the flow line easement are the prohibition of deep ripping of soils and the use of cutting discs which may damage the flow line. Limitations also exist that prevent the excavation of earth within the easement for the construction of dwellings and farm dams etc, however, these activities are additionally prohibited under various local and state planning laws relating to developments in close proximity to fence lines and property boundaries.

Limiting where possible the placement of the flow line along existing fence lines, property boundaries and uncleared shelter belts/road easements and the capacity for an immediate resumption of production activities serves to highlight the suitability of the proposed flow line route.

As a means to minimise the disruption of the proposed activity on the management of stock within pasture operations, the construction activity would be preceded by the erection of temporary fencing along the disturbance corridor to:

- Exclude stock from the working area; and
- Remove the need for the landholder to move stock animals during the construction period.

The temporary fencing would be retained until such time as the landholder has provided signoff on the working area rehabilitation program.

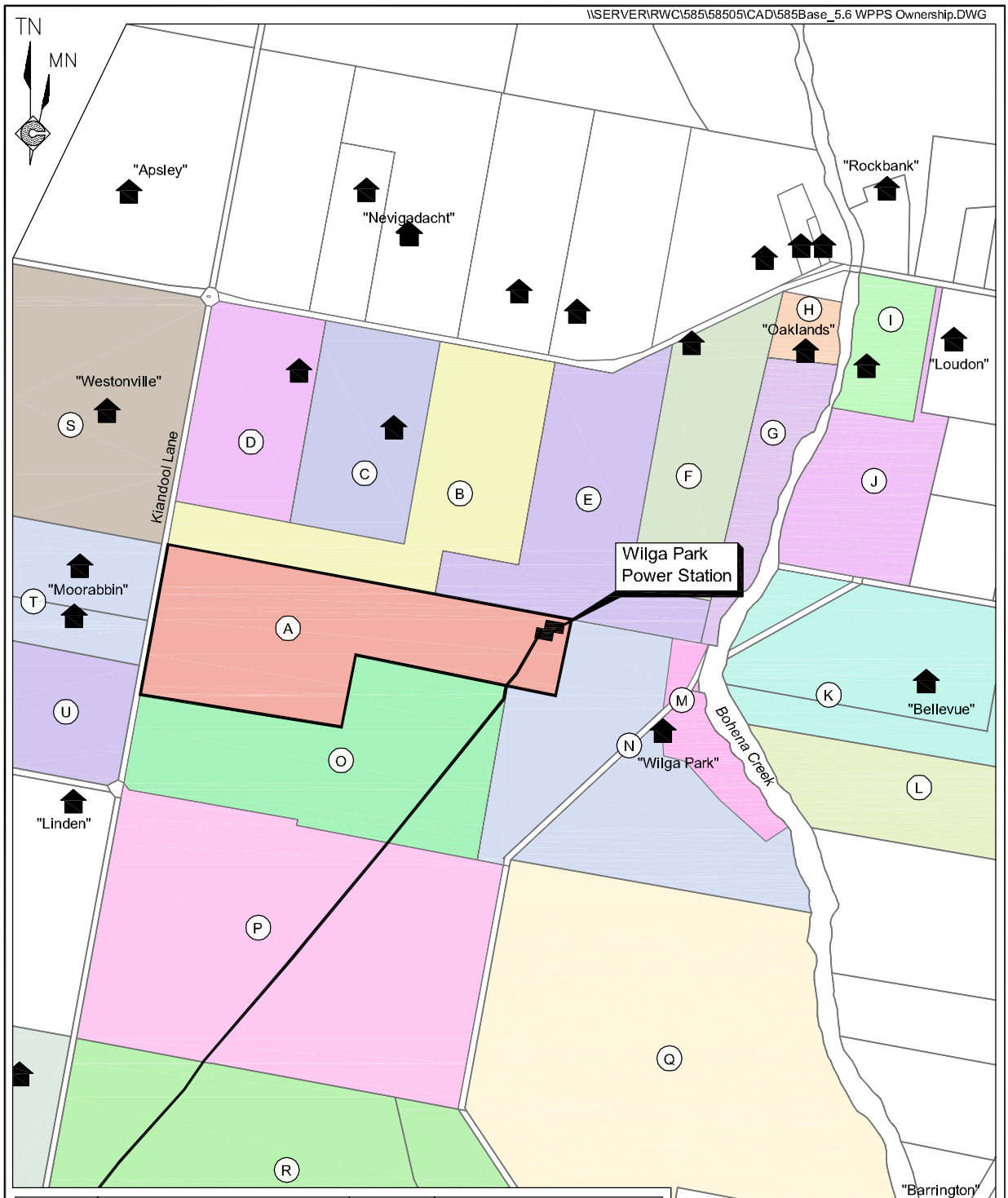
Residential Proximity

Figure 5.5 displays the proximity of residences to the proposed gas flow line corridor. The approximate distances of the residences within 2.8km of corridor are listed in **Table 5.1**. **Figure 5.5** also displays that "Burrawama Park" is the closest residence to the proposed compression facilities at both Bibblewindi (CSG Pilot) (4.1km) and Bohema (CSG Pilot) (5.9km).

Figure 5.6 displays the location of the residences generally within approximately 4km of the Wilga Park Power Station. The approximate distance to a selection of these residences to the power station are also listed in **Table 5.1**.

Table 5.1
Proximity of Residences to the Gas Flow Line Corridor and Wilga Park Power Station

Gas Flow Line Corridor		Wilga Park Power Station	
Residence*/ Owner	**Distance to (m)**	**Residence# / Owner**	**Distance to (m)**
"Wilga Park"	880	"Oaklands"	2 400
"Moorabbin"	2 700	"Loudon"	3 200
"Linden"	2 600	"Bellevue"	2 400
"Taradale"	780	"Wilga Park"	880
J Nehrkorn	1 300	"Linden"	3 400
"Marooma"	200	"Moorabbin"	3 200
AL McNamara	2 800	"Westonville"	3 300
BJ Gosper	500	"Apsley"	3 900
"Clarendon"	2 400	"Nevigadacht"	3 200
"Wilga View"	1 300	"Rockbank"	3 600
"Rosewood Farm"	1 400	M & T Wilson	2 300
ML & DP Pringle	2 000	T. Browning	1 600
"Albion Park"	2 200	R. Hatch	2 000
"Glenwood"	1 500	E. Gordon, M. Thrift & R. Baker	
* see Figure 5.5			# see Figure 5.6



Reference	Owner	Reference	Owner
A	Narrabri Power Limited	K	P. & Z. Swain
B	R. & D. Cochrane	L	K.,K.,F. & C. Hill & D. & J. Canfell
C	T. V. Browning	M	K. & R. Archer
D	M. & T. Wilson	N	R.G. Archer
E	P. Hardcastle	O	J.D. Williams
F	R. & D. Hatch	P	B.W. Cain
G	G. & L. Stanford	Q	L. Hodges
H	I. & P. Shields	R	C.B. & A.M Cain
I	E. & T. Gordon, M. Thrift & R. Baker	S	J. Charles
J	A. Steele	T	F. Wales
		U	R. Fenn

REFERENCE
Proposed Gas Flow Line Corridor
Cadastral Boundary
Residence

SCALE 1:40 000

0.5 0 0.5 1.0 1.5 2.0 km

Base Map Source: Narrabri & Baan Baa 1:50 000 Topographic Maps

Figure 5.6
RESIDENCES SURROUNDING
WILGA PARK POWER STATION

5.2 Air Quality, Greenhouse Gases and Air Dynamics

The main project-related activities identified as likely to impact upon local air quality and greenhouse gases are as follows.

- The generation of fugitive dusts from the installation of the gas gathering system and gas flow line.
- The consumption of fuels and the associated generation of greenhouse gases during construction of the gas gathering system, gas flow line and expanded power station from sources such as transport vehicles, construction machinery.
- The operation of the expanded Wilga Park Power Station.

This section also presents a brief plume rise assessment for the emissions from the Wilga Park Power Station carried out in consultation with the Civil Aviation Safety Authority.

The assessment of the potential, likely and actual air quality impacts of the Project, the greenhouse gas assessment and plume rise assessment has been undertaken by Heggies Pty Ltd (Heggies). The assessment report is included as Part 1 in the *Specialist Consultant Studies Compendium* with the relevant information from the assessment summarised in the following subsections.

5.2.1 Air Quality

5.2.1.1 Introduction

The comprehensive air quality and greenhouse gas impact assessment has been prepared in accordance with *Approved Methods for Modelling and Assessment of Air Pollutants in NSW (DEC, 2005)* (AMMAAP) with particular reference to oxides of nitrogen (NO_x) and cumulative air emissions at local, regional and interregional levels.

Brief reference is provided for dust generation and management during the construction phase.

5.2.1.2 The Existing Environment

The air quality in the vicinity of the Project Site is representative of a rural primary production environment and its common land use practices.

- The air quality is influenced by a range of agricultural production and transport activities. The generation of fugitive dusts and exhaust emissions from vehicle and mechanised equipment generally defines the localised environment in terms of air quality.
- Air quality in the Pilliga State Forest is influenced predominantly by fugitive dusts generated by vehicular traffic on dirt roads, incidental exhaust emissions from forestry operations and smoke from bush fires.

Closer to the Narrabri township, air quality is influenced by more intensive industry based activities such as sawmilling, cotton seed processing and more commonly from the increased density of inhabitation (eg. smoke and incidental emissions from farm and domestic activities).

The existing environmental conditions across the Project Site have been characterised by Heggies Pty Ltd. Quantitative air quality data for the existing environment has been derived using monitoring data from the DECC monitoring site located approximately 320km southeast of the Project Site. In the absence of data sets closer to the Project Site, the Beresfield monitoring station is expected to provide an overestimate of background concentrations of air pollutants such is its proximity to industrial and suburban settings likely to increase such background levels of pertinent air pollutants. This conservatively high estimate has been employed to account for Section 5.2 of the AMMAAP.

5.2.1.3 Potential Impacts and Assessment Criteria

The assessment criteria applicable to air quality (see **Table 5.2**) have been adopted from available NSW guidelines including DECC air quality criteria for nitrogen dioxide and the *Protection of the Environment Operations (Clean Air) Regulation 2002*.

Table 5.2
Air Quality Criteria Derived from DECC Air Quality Guidelines

Pollutant	Averaging Time	Max Allowable Conc.
NO_2 (ambient)	1 hour	246µg/m^3 (on ground)
	Annual	62µg/m^3 (on ground)
NO_2/NO or both (as NO_2 equiv)	N/A	450mg/m^3 (in stack conc.)
Deposited Dust/PM_{10}	Monthly	4g/m2/month

The inclusion of atmospheric dispersion modelling compliments the stated assessment criteria for expected pollutants.

5.2.1.4 Mitigation of Potential Impacts

Various Project-related activities are likely to contribute to the generation of fugitive dusts in the area immediately surrounding the gas flow line corridor. They include:

- preparatory activities within the gas flow line corridor including vegetation clearance, topsoil stripping and trench excavation;
- rehabilitation activities the gas flow line corridor including trench backfilling, topsoil redistribution and retained vegetation replacement; and
- vehicular transport movements to and from and within the gas flow line corridor.

In order to ensure that the maximum allowable dust generation and deposition thresholds are maintained during the construction phase of the Project, the following safeguards are proposed to limit the generation of fugitive dusts.

Table 5.3
Fugitive Dust Control Measures for Implementation During Project Implementation

Dust Sources	Safeguards/Mitigation Measures
Vegetation modification / removal	• No specific dust suppression safeguards possible within forested section during this phase due to access issues. • Strict observation of maximum 10m wide disturbance corridor where vegetation is to be cleared. • Retention of vegetation for use in rehabilitation program.
Topsoil Stripping	• Dust suppression where permissible (see Soils impact assessment). • Additional dust suppression on retained soil stockpiles where required.
Rehabilitation	• Replacement of retained vegetation as soon as practicable post backfilling and compaction for topsoil stabilisation and limit dust mobilisation.
Monitoring	• Periodic monitoring of rehabilitated disturbance corridor focusing on topsoil stability. • Additional measures including application of approved groundcover/grass species seed on problematic areas to stabilise soils during the interim.

The proposed safeguards outlined have been assessed as suitable in providing adequate degree of dust suppression during the various stages of project implementation. The short term nature of the project, the small area subject to construction activities and the stated mitigation measures reduce the risk of surpassing stated dust deposition thresholds to an acceptable level.

5.2.1.5 Assessment of Potential Impacts

The major emission sources include:

- 10 x 1 MW gas engines (as per existing configuration); and
- 10 x 3 MW gas engines (proposed expansion).

Dispersion Modelling

The atmospheric dispersion modelling carried out by Heggies utilises the Ausplume Gaussian Plume Dispersion Model software developed by EPA Victoria. This model is frequently used for industrial emissions assessment within NSW. Default options specified in the technical users manual (EPA Victoria, 2000) have been used in accordance with the AMMAAP (Heggies, 2007).

Heggies (2007) state that in order that the air quality assessment withstands the rigors of both legislative and scientific appraisal, assumptions as to plant configuration have been minimised within the atmospheric dispersion modeling. Where possible, the emission rates and exhaust parameters have been sourced directly from manufacturers' technical data.
Climatic data used in modelling were obtained from the nearest Bureau of Meteorology (BoM) Automatic Weather Station (AWS) located at Narrabri Bowling Club.

The assumptions used in the completion of the assessment are outlined in Section 5.7 of Heggies (2007).

NOx Modelling

In terms of human health and the appropriate DECC assessment criteria, Heggies indicate that nitrogen dioxide has been considered as a potential air emission of concern and impacts are thus investigated using the atmospheric dispersion model.

5.2.1.6 Modelling Assumptions

In order that this air quality assessment withstands the rigors of both legislative and scientific appraisal, assumptions as to plant configuration have been minimised within the atmospheric dispersion modelling.

Where possible, emission rates and exhaust parameters have been sourced directly from manufacturers' technical data. However it is inevitable that some assumptions have been used. These assumptions have been outlined below.

In the absence of mass emission rate data from the existing stationary gas turbines, the National Pollutant Inventory (NPI) Emission Estimation Technique Manual for Fossil Fuel Electric Power Generation has been used to obtain oxides of nitrogen emission factors. In the interests of conservatism, the uncontrolled emission factor has been used.

Stack parameters for the existing 10 x 1MW gas turbine units have been assumed to be the following:

- Stack height – 3.8m;
- Stack exit velocity – 12m per second;
- Stack diameter – 0.33m; and
- Stack temperature – 375° C.

Stack parameters for the proposed, upgraded 10 x 3 MW reciprocating gas engine units have been assumed to be the following (based on information provided by the supplier);

- Stack height – 12.5m;
- Stack exit velocity – 12m per second;
- Stack diameter – 0.6m; and
- Stack temperature – 375° C.

Power station operation would occur 24 hours per day, 365 days per year.

Mass emission rates for the proposed Jenbacher JGS620 GS-S.L 3MW reciprocating gas engine units have been obtained from the supplier, negating the need for emission factors to be employed. Data provided by the supplier also verified that the maximum in-stack concentrations of NO_x would not exceed 450mg/m^3.

5.2.1.7 Modelling Results

Atmospheric Dispersion Modelling Results

The results of the Ausplume predictions for the 1-hour maximum and annual average NO_2 concentrations at each of the seven identified receptors utilising the Ozone Limiting Method of NOx conversion method (see Section 5.8 of assessment report) are shown in **Table 5.4** and on **Figure 5.7**.

Table 5.4
Predicted Maximum 1 hour and Annual Average NO_2 Concentrations at Nearest Receptors*

Receptor	Averaging Times	Pollutant Concentrations – µg/m^3				
		Predicted NOx from Ausplume (increment only)	Background NO_2	Background O_3	OLM Calculated NO_2 (Background + Increment)	Project Goal
"Oaklands"	1 hour	79	12	83	91	246
	Annual	1	17	35	18	62
"Loudan"	1 hour	69	59	29	94	246
	Annual	1	17	35	18	62
"Bellerue"	1 hour	35	57	37	92	246
	Annual	1	17	35	18	62
"Barrington"	1 hour	114	6	59	74	246
	Annual	1	17	35	18	62
"Meriville"	1 hour	39	48	35	85	246
	Annual	2	17	35	19	62
"Linden"	1 hour	55	49	35	88	246
	Annual	1	17	35	18	62
"Moorabin"	1 hour	32	70	35	102	246
	Annual	1	17	35	18	62
"Wilga Park"	1 hour	91	25	69	101	246
	Annual	3	17	35	20	62

* Using the Ozone Limiting Method

The dispersion modeling results in lower than predicted NO_2 concentrations at each receptor. Using this method, the maximum 1 hour NO_2 concentration is predicted to be 102µg/m^3 at Receptor 7 in comparison with 176µg/m^3 at Receptor 8, assuming that 100% of the emitted NO is converted to NO_2. Heggies consider the application of the Ozone Limiting Method represents an outcome closer to what may be expected in reality, while still being conservative in its approach.

Performance against Regulation Emission Limits

Heggies compare the performance of the Wilga Park Power Stations in-stack NOx concentrations against the criteria specified the *Protection of the Environment Operations (Clean Air) Regulation 2002*.

Manufacturer's data for the GE Jenbacher JGS620GS-S.L gas engines states a maximum emission concentration of 450mg/Nm^3 of NO_x. The results are based on reported in-stack normalised concentrations using a reference O_2 concentration of 3% and a discharge volume of 12 293Nm^3/hour (***source:*** *GE Jenbacher engines technical specifications*). The above test data indicates that predicted in-stack concentrations are predicted to satisfy the Regulation emission-based limits for scheduled activities.

Efficiency and Performance Compliance

The GE Jenbacher reciprocating gas engines to be installed at the Wilga Park Power Station represent the most advanced electricity generation systems available at the present time. Pre-combustion chambers ensure maximum efficiency and lean burn control ensures minimal emissions. These units currently represent best practice in emissions control. Evidence of the compliance with stated air quality guidelines for the gas driven engines is provided in **Appendix 6B**.

In order to ensure that maximum efficiencies and performance of the gas driven engines are achieved and maximum in stack NO_2 concentrations are met to the satisfaction of the *Protection of the Environment Operations (Clean Air) Regulation 2002*, scheduled maintenance of the units and associated electricity transmission infrastructure would be undertaken. The maintenance schedule would be established in accordance with the requirements of the manufacturer and in close consultation with the DECC regulations for the operation of electricity generation facilities and the minimisation of gaseous emissions.

Odour Assessment and Management

The operation of the GGS and gas flow line linking the CSG pilots and the Wilga Park Power Station pose no measurable risk to the surrounding environment, land uses or landholders from odours or activities associated with the proposal and in consideration of the *Approved Methods for Modelling Air Pollutants in NSW (DEC, 2005)* or the *Technical Framework - Assessment and Management of Odour from Stationary Sources in NSW* (DEC, 2006).

The GGS and flow line infrastructure does not possess any air discharge points that require an assessment under this guideline. Furthermore, the CSG produced and transported via the infrastructure is odourless and poses no measurable likelihood of impacting on the environment at its origin or destination or on any receptor within the vicinity of the Project Site.

Dust Related Impacts

The adoption of conventional dust suppression techniques would result in comparatively low levels of dust generation during the construction phase of the Project. The short-term duration of the installation activities and their transient nature would result in negligible and acceptable impacts upon surrounding residents.

5.2.2 Greenhouse Gases

5.2.2.1 Introduction

The proposed development has the potential to generate greenhouse gases from various point sources including the planned ongoing operation of the Wilga Park Power Station. The assessment of likely and actual emissions has been conducted in accordance with the NSW Department of Environment and Climate Change (DECC) *Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW (2005) (herafter AMMAAP)*.

The Project-related greenhouse gas sources include:

- the combustion of CSG in electricity generation;

- emissions associated with CSG extraction, processing, transmission and distribution;
- diesel fuels consumed during installation of the GGS and gas flow line; and
- greenhouse gas sources associated with off-site sources such as electricity consumption during operations.

The greenhouse gas assessment for the power station component of the Project is a key assessment requirement specified in the DGRs. Further comparison is made in the assessment between the relative greenhouse gas emissions from the combustion of the CSG for electricity generation and the venting of the raw methane to atmosphere. There remains a significant environmental incentive to limit wherever possible the emission of greenhouse gases to atmosphere during the assessment and development of this energy resource.

The specific DGRs for the greenhouse gas impact assessment are:

"Greenhouse Gas Impacts (power station component) – The Environmental Assessment must include a comprehensive greenhouse gas assessment, incorporating a quantitative model showing the tonnages of each greenhouse gas produced (directly and indirectly from the project) on the bass of each unit of production (MWh); total annual emissions; and project lifetime. Annual emission figures must also be expressed as a percentage of the total national and state greenhouse gases produced per year over the life of the project, and should be compared against bets practice emissions for reciprocating engine driven generation and alternative electricity generation technologies. The feasibility of implementing additional measures to reduce greenhouse gas emissions must be evaluated. If a greenhouse gas offset if proposed, full details of the offset(s) must be included on the Environmental Assessment and the feasibility of its application assessed."

Heggies have considered the Project's potential to generate greenhouse gas emissions in response to the above requirements in a specific Greenhouse Gas Assessment.

Two of three specific greenhouse gas emission scopes have been included in the assessment.

1. Emissions resulting from activities under the company's control or from sources which it owns (eg. on-site electricity generation, emissions related to CSG production).
2. Emissions generation of purchased electricity consumed in owned/controlled equipment or operations.

The third scope discussed by Heggies is not relevant to this assessment.

Project-related greenhouse gas sources have been described as:

- combustion of CSG in electricity generation (Scope 1);
- emissions associated with CSG extraction (Scope 1);

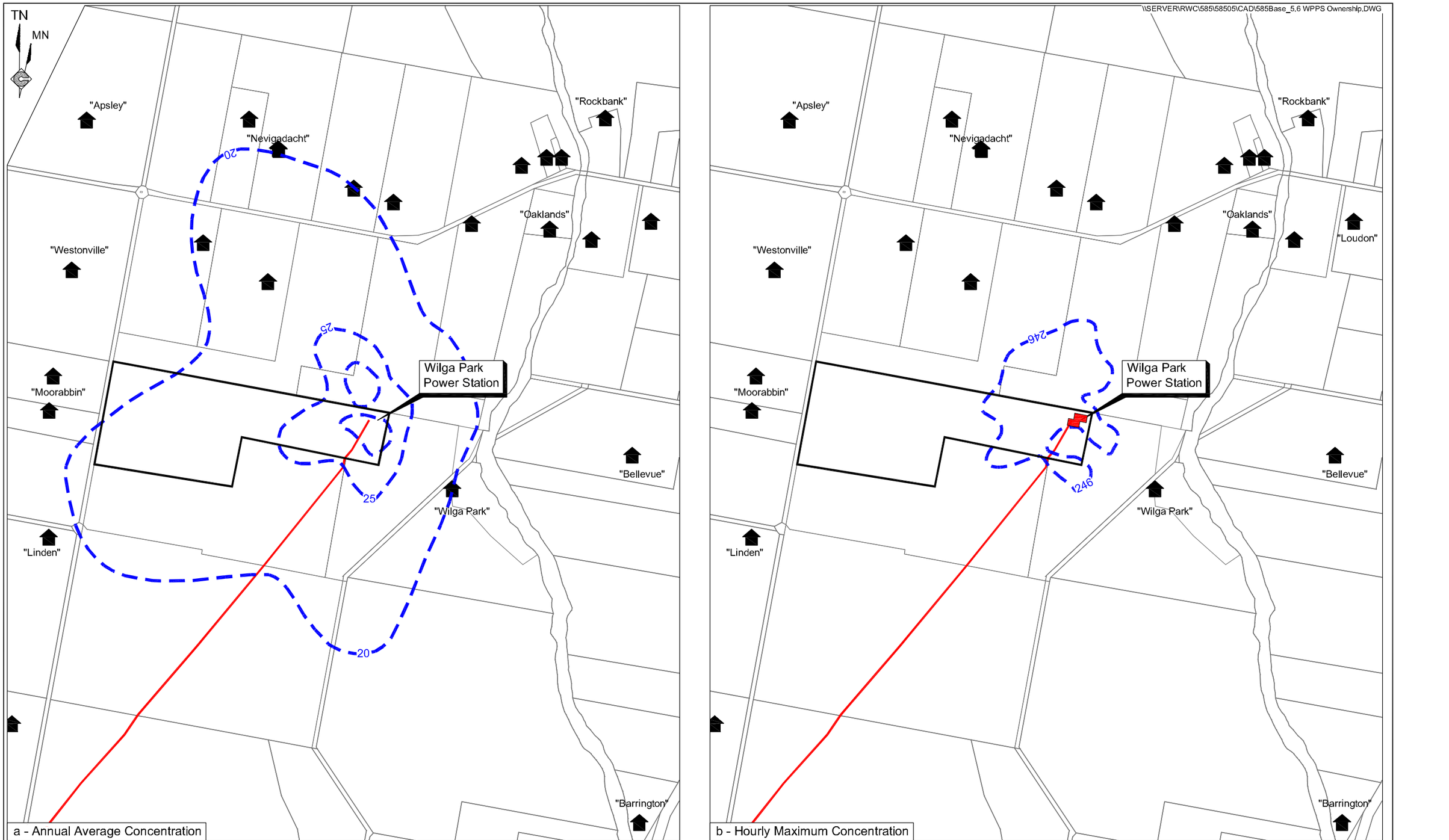


Figure 5.7
PREDICTED NO_2 CONCENTRATIONS
AROUND THE WILGA PARK POWER STATION

- diesel fuels consumed during project implementation (Scope 1);
- emissions associated with production, processing, transmission and distribution of CSG (Scope 1); and
- emissions associated with electricity consumption during operational phases (Scope 2).

5.2.2.2 Emissions Review

Carbon dioxide (CO_2) is produced during the combustion of fuels as a result of carbon oxidation. CO_2 is likely to make the largest contribution to greenhouse gas emissions from fuel combustion as approximately 99.5% of natural gas is oxidised during the combustion process (AGO, 2005 in Heggies, 2007).

Other greenhouse gases expected to be emitted during the operation of the proposed development include carbon monoxide (CO), methane (CH_4), nitrogen oxides (NO_X) and non-methane volatile organic compounds (NMVOCs). These compounds are produced from the coal itself, incomplete fuel combustion, reactions between air and fuel constituents during fuel combustion, and post-combustion reactions. Fugitive emissions of NMVOCs may also be expected due to fuel evaporation.

In accordance with the Australian Greenhouse Office document *AGO Factors and Methods Workbook –December 2006* (AGO, 2006) the greenhouse gas emissions that are required for measurement from the Project are Direct (Scope 1) emissions relating to on-site fuel combustion and fugitive coal seam methane release, and Indirect (Scope 2) emissions resulting from the purchase and consumption of electricity. There are not envisaged to be any Indirect (Scope 3) emissions associated with the Project.

For comparative purposes, non-CO_2 greenhouse gases are awarded a "CO_2-equivalence" based on their contribution to the enhancement of the greenhouse effect. The CO_2-equivalence of a gas is calculated using an index called the Global Warming Potential (GWP). The GWP's for a variety of non-CO_2 greenhouse gases are contained within Table 23 of the AGO Workbook.

The GWP's of relevance to this assessment are:

- Methane (CH_4): GWP of 25 (25 times more effective as a greenhouse gas than CO_2); and
- Nitrous Oxide (N_2O): GWP of 310 (310 times more effective as a greenhouse gas than CO_2).

The short-lived gases such as CO, NO_2, and NMVOCs vary spatially and it is consequently difficult to quantify their global radiative forcing impacts. For this reason, GWP values are generally not attributed to these gases nor have they been considered further as part of this assessment.

An assessment of the predicted greenhouse gas emissions from the Project's operation has been undertaken for each source. It is noted that the scope of this greenhouse gas assessment is to account for emissions directly related with the installation and operation of the gas flow line and power station expansion.

Venting of CSG is currently occurring at the Bibblewindi and Bohena CSG pilots. An assessment has been undertaken which estimates the potential greenhouse gas emissions due to the continued venting of CSG. This demonstrates the value of gas combustion as opposed to venting in terms of greenhouse gas emission potential.

5.2.2.3 Gas Combustion for Electricity Generation

The primary fuel source for electricity generation at Wilga Park Power Station would be Coal Seam Gas (CSG). Based on information supplied by the Proponent, the expected CSG consumption rate associated with on-site electricity generation activities during the operational phase would be approximately 3.7 PJ per year. The annual emissions of CH_4, CO_2, and other greenhouse gases from this source have been estimated using Table 2 of the AGO Workbook (AGO, 2006). Emission factors for Natural Gas have been used which specifically include emissions from combustion of coal seam methane.

The maximum predicted greenhouse gas emission in tonnes per unit of production, total annual and on a total project lifetime basis referred to in the DECC *Environmental Assessment* requirements are shown in **Table 5.5** and **Table 5.6**.

Table 5.5
Predicted Greenhouse Gas Emissions from CSG Combustion

	CSG Consumption (GJ)	Emission Factor (kg CO_2-e/GJ)	Greenhouse Gas Emissions (t CO_2-e)
Per Unit	1 (per unit)	51.7	0.0517
Annual	3700 000	51.7	191 290
Lifetime (≈20 yrs)	74 000 000	51.7	3 825 800

Table 5.6
Predicted Annual Greenhouse Gas Emissions from CSG Production (Fugitive Emissions)

Throughput (PJ)	Emission Category	Emission Factor (Gg CO_2-e/PJ)	Greenhouse Gas Emissions (t CO_2-e)
3.7	Production and Processing	0.016	59
3.7	Transmission	0.178	659
3.7	Distribution	3.259	12 058
		Total	**12 776**

5.2.2.4 Emissions Associated with CSG Extraction

Unavoidable fugitive emissions of methane, carbon dioxide and NMVOCs would be associated with any fuel extraction process. Emission factors for the production, processing and transmission of natural gas have been estimated using Table 7 of the AGO Workbook (AGO, 2006). An emission factor relating to the distribution of natural gas is also provided which has been included in this assessment. It is hoped that after 18 months, if the resource is proven, wider distribution of the CSG would occur and therefore distribution losses of greenhouse gases would occur.

Diesel Consumption

The primary fuel source for the excavation equipment and trucks associated with installation of the gas flow line would likely be Automotive Diesel Oil (ADO). Assumptions for Project-related diesel consumption during the installation of the gas flow line have been made as follows.

- Excavation of a 0.3m x 0.8m x 32km trench would require removal of approximately 8 100m^3 of topsoil and subsoil.
- Excavator diesel consumption of 100L/hr (based on Hitachi Ex110).
- Haul truck diesel consumption of 0.6L/km (based on a B-Double configuration).

Based on the above conservative assumptions, diesel consumption associated with the excavation and installation of the gas flow line from Bibblewindi to the Wilga Park Power Station would result in the consumption of approximately 48KL. The annual emissions of CO_2 and other greenhouse gases from this source have been estimated using Table 3 of the AGO Workbook (AGO, 2006) – see **Table 5.7**. It has been assumed that the energy content of ADO is 38.6MJ/L (AGO, 2006).

Table 5.7
Predicted Greenhouse Gas Emissions from Implementation of the Proposal

Diesel Consumption (kL)	Energy Content (MJ/kL)	Emissions Factor (kg CO2-e/GJ)	Greenhouse Gas Emissions (t CO2-e)
48	38.6	69.8	129

Electricity Consumption

Electricity would be used on-site for office buildings, office equipment and other general uses within the compound for the Wilga Park Power Station. In terms of emissions, this usage would constitute a negligible amount of the total emission of greenhouse gases. Therefore, Scope 2 electricity usage has not been considered further within this assessment.

Total Annual Greenhouse Gas Emissions

As shown in **Table 5.8** the total estimated annual emissions of CO_2-Equivalent as a result of operations at the site are likely to be of the order of 204 200t of CO_2-Equivalent per annum. Greenhouse gas estimates are assessed relative to 1990 baseline levels for reporting purposes.

The AGO estimates Australian greenhouse gas emissions totaled 551.9Mt CO_2-equivalent in 1990. A comparison of the predicted emissions with the 1990 estimate demonstrates that operations would represent an annual increase of approximately 0.04% of the total baseline Australian emissions.

Table 5.8
Predicted Annual Greenhouse Emissions from Proposal

Source	Predicted Emissions (t CO_2-e)
Gas combustion/Electricity Generation	191 290
Emissions (CSG Production)	12 776
Diesel Combustion Emissions	129
Total	**204 193**

Venting of CSG

The proposed upgrade to the Wilga Park Power Station would result in the combustion of CSG from the Bibblewindi and Bohena CSG Pilots. In future years, some gas may be on-sold and distributed for combustion elsewhere. At the present time, CSG being produced is being vented to atmosphere whilst approvals are being sought for the installation of infrastructure linking the gas supplies with the power station. CSG gas vented directly to the atmosphere has a greater global warming potential than combusted CSG due to the high (≈88%) methane content of the gas, coupled with the GWP of methane (21 times the GWP of CO_2). Calculations of greenhouse gases from venting, in terms of CO_2-e have been calculated for the same gas consumption and throughput values used in **Table 5.9** and **Table 5.10** to demonstrate the lower greenhouse gas emissions resulting from combustion. These calculations are shown in **Table 5.11**.

Table 5.9
Predicted Annual Greenhouse Gas Emissions from CSG Venting

Gas	Predicted Emissions (t)	Predicted Emissions (t CO_2-e)
Methane (CH_4)	67 820	1 424 216
Carbon Dioxide (CO_2)	7 408	7 408
	Total	**1 431 624**

As shown in **Table 5.9** the total estimated annual emissions of CO_2-Equivalent as a result of the continued venting of CSG at the Bibblewindi CSG Pilot is likely to be of the order of 1.5Mt of CO_2- Equivalent per annum.

Comparison with NSW and National Totals

Data sourced from the Australian Greenhouse Office (AGO) indicate in their publication, *State and Territory Greenhouse Gas Inventories 2005*, that the NSW and National greenhouse gas emissions totalled 158.2 and 559.1 million tonnes of CO_2-Equivalent respectively.

A comparison of the predicted emission from the project and the atmospheric venting alternative with the NSW and National figures is made in **Table 5.10**.

Table 5.10
Comparison Emissions Figures on the Project, Venting Option, State and National Figures

Source	Emissions (t CO_2-e)	% of National
Project	204 193 (predicted)	0.0365%
Atmospheric venting option	1 431 624 (predicted)	0.256%
NSW annual total	158 200 000	28.29%
National annual total	559 100 000	

The comparison of predicted emissions with the 2005 State and National emissions figures suggests that that the proposed combustion of the produced CSG at the Wilga Park Power Station would represent an increase of approximately 0.04% the total baseline Australian emissions for 2005 or 0.265% from the venting of the CSG to atmosphere. It is noted that this figure does not account for the additional energy capture through electricity generation through the combustion of the CSG. Thus the combustion of the CSG for electricity generation is more prudent in terms of greenhouse abatement compared with the status quo (venting of CSG direct to atmosphere).

Upstream/Downstream Emissions

The cumulative upstream emissions associated with this proposal have been described in the preceding sections. No additional downstream sources of greenhouse gas emissions can be attributed to the process of CSG extraction, transmission and combustion as described based upon the full utilisation of the produced gas at the Wilga Park Power Station.

Conclusions

The atmospheric dispersion modeling carried out in the present assessment utilises the Ausplume Gaussian Plume Dispersion Model software developed by EPA Victoria, Version 6.0. The impact of NO_2 emissions from the proposed plant has been assessed at the eight closest residential receptors to the Wilga Park Power Station. Two methods of calculating NO_2 have been utilised, one a highly conservative approach, and one which seeks to represent NO_2 chemistry more closely. Both methods indicate that the predicted NO_2 concentrations are anticipated to be below the health based project goals of 246µg/m^3 (1 hour maximum) and 62µg/m^3 (annual average) at all residential receptors.

Emissions of dust would be experienced during the construction of the CSG pipeline from the Bibblewindi plant to the power station and when constructing the necessary infrastructure for the upgrade itself. However, due to the large buffer distance between the power station and the nearest residence (0.9km) and the low density of residences along the flow line route, these impacts are anticipated to be easily managed through good dust management practices. Considering the above air quality modeling results, it is concluded that the proposed upgrade to the Wilga Park Power Station would not have a detrimental health impact upon the surrounding residential receptors.

Greenhouse gas emissions due to extraction of the CSG, combustion at the Wilga Park Power Station and diesel use during the construction of the flow line from the Bibblewindi plant have been assessed as part of this air quality assessment. The comparison of predicted emissions with the 2005 State and National emissions figures suggests that that the proposed combustion of the produced CSG at the Wilga Park Power Station would represent an increase of approximately 0.0365% the total baseline Australian emissions for 2005 or 0.265% from the venting of the CSG to atmosphere. A comparison of the two options demonstrates that equivalent emissions would be in the order of 7.2 times greater if the gas was vented to atmosphere preferentially over its collecting and combustion at the Wilga Park Power Station.

5.2.3 Air Dynamics

5.2.3.1 Introduction

The Proponent has consulted with the Civil Aviation Safety Authority (CASA) to enable the provisions of CASA Advisory Circular *AC 139-05(0) Guidelines for Conducting Plume Rise Assessments* to be addressed. The Advisory Circular provides guidance to…*'persons involved in the design, construction and operation of facilities with exhaust plumes about the information required to assess the potential hazard from a plume rise to aircraft operations'*.

The Civil Aviation Safety Authority (CASA) requires that a full plume rise assessment be undertaken where a proposed facility is located within 15km of an aerodrome and if the facility includes a combustion source which generates an exhaust plume which has a vertical velocity greater than 4.3 m/s at the height of the Obstacle Limitation Surface. According to CASA's Advisory Circular entitled *Guidelines for Conducting Plume Rise Assessment* (June 2004), exhaust plumes with a vertical velocity in excess of 4.3 m/s may cause damage to an aircraft airframe, or upset aircraft flying at low levels.

Narrabri Airport is located just over 15 km to the east-northeast of the Wilga Park Power Station and is therefore outside of the Obstacle Limitation Surface for Narrabri Airport. Hence, a full plume rise assessment is not required. However, CASA also state that outside of the Obstacle Limitation Surface, if the top of the structure is 110 m or more Above Ground Level or if the vertical velocity of the plume at 110 m Above Ground Level exceeds 4.3 m/s, CASA may determine that the facility would be a hazard to aircraft operations because of the velocity or location of the efflux.

The Proponent commissioned Heggies Pty Ltd to conduct the appropriate modelling and analysis of plume rise impacts from the operation of the Wilga Park Power Station. The following section has been summarised from this report.

5.2.3.2 Plume Rise Assessment

Critical Vertical Velocity

In accordance with CASA requirements, the frequency with which the average vertical plume velocity exceeds the critical vertical velocity has been calculated. Analysis of the plume rise data indicates that the critical vertical velocity of 4.3 m/s is not exceeded at any height. The lowest height of the plume output from the model is 20m.

Table 5.11 shows the maximum, minimum and average vertical velocity and the average height at which these velocities are predicted.

Table 5.11
Average Vertical Velocity and Height

	Vertical Velocity (m/s)	Average Height AGL (m)
Minimum	0.03	57.2
Average	0.89	61.8
Maximum	4.2	24

Table 5.12 shows the maximum, minimum and average plume heights and the average vertical velocity of the plume predicted at these heights.

Table 5.12
Average Plume Heights and Vertical Velocity

	Height AGL (m)	Average Vertical Velocity (m/s)
Minimum	20	2.1
Average	71	0.5
Maximum	531	0.99

Table 5.13 indicates that the maximum vertical velocity predicted is 4.2 m/s at an average height of 24m above ground level. This is well below the CASA criterion of 4.3 m/s at 110m above ground level. **Table 5.12** shows that the maximum height of the plume is 531m above ground level and the average vertical velocity at this height is 0.99 m/s.

Table 5.13
Minimum, Average and Maximum Plume Vertical Velocity at 110m AGL

	Vertical Velocity (m/s)
Minimum	0.04
Average	0.5
Maximum	1.67

Further analysis of the data provides information on the vertical velocity of the plume at 110m above ground level, as requested by CASA and as shown in **Table 5.13**. The maximum vertical velocity of the plume at 110m above ground level is predicted to be 1.67 m/s, well below the CASA criterion of 4.3 m/s.

The maximum vertical velocity of the plume from the Wilga Park Power Station is predicted to be 4.2 m/s at 24m above ground level. The maximum plume height is predicted to be 531m above ground level. The associated plume vertical velocity at 531m above ground level is predicted to be 0.99 m/s. An assessment of the plume vertical velocity at 110m above ground level, as requested by CASA, indicates that the maximum velocity is predicted to be 1.67 m/s. This is significantly below the CASA criterion of 4.3 m/s.

5.3 Flora

The flora assessment was undertaken by Greg Elks of *Idyll Spaces Environmental Consultants* (hereafter referred to as "Idyll Spaces"). The assessment is presented in full as Part 2 of the *Specialist Consultant Studies Compendium* with the relevant information from the assessment summarised in the following subsections. The assessment is referred to as Idyll Spaces (2008).

5.3.1 The Existing Environment

5.3.1.1 Literature Review

Smith (2002), during preparation for the 2001 Pilliga East Seismic Survey, suggested that the Pilliga State Forests and Nature Reserve, including Bibblewindi State Forest, form the largest forest remnants on the northwest slopes and plains of NSW and has national, state and regional conservation significance for the protection of biodiversity and threatened species due to its large size (>500 000 ha), high species diversity and high quality habitat.

The Pilliga East State Forest, covering approximately 32 000ha, is a small native forest zone managed by Forests NSW. Little published work on the vegetation composition of the forest is available (Clements and Moore, 2002). Prior to the commencement of the Western Regional Assessment for the Brigalow Belt South Bioregion Assessment, published reference material on the vegetation composition of the region was scant. The Bohena CSG Pilot area lies wholly within the boundary of the Pilliga East State Forest and the Bibblewindi CSG Pilot lies within the Bibblewindi State Forest, bounded to the north by Jacks Creek State Forest and to the west, south and east by the Pilliga East State Forest.

The dominant canopy species mapping maintained by Forestry NSW references two communities, Narrow leaf Ironbark/Bull Oak/White Cypress and White Cypress/Narrow leaf Ironbark/Bull Oak (in order of dominance). These original map strata have been developed for commercial management rather than ecological purposes and disturbance regimes (e.g. logging, severe bushfire) since the date of mapping may have changed the species dominance (Idyll Spaces, 2005).

During the development of the *Brigalow and Nandewar Community Conservation Bill Act 2005* by the NSW State Government, much of the Pilliga East State Forest was declared a Zone Four Community Conservation Area (CCA). Almost 150 000 ha of Forests NSW land in the Pilliga East, Bibblewindi and Jacks Creek State Forests has been reclassified Zone Four CCA allowing forestry, recreation, exploration and mining activities to continue.

The extent of flora surveying efforts in the area south and southwest of Narrabri has steadily grown since the surveys of Clements and Associates in 2002. The area surveyed to date now approximates 40% of PAL2 from the Bibblewindi CSG Pilot through to Bohena South, the Bohena CSG Pilot and the northern forest/open land interface. A majority of the surveying effort has been allocated on the basis of one survey plot and one random meander for communities up to approximately 5ha in area, and two plots and one random meander for communities of 5-50ha. Structural and floristic data was collected from the 20m x 20m survey plots. The random meander searches were undertaken around the Study Area targeting plant species of conservation significance.

5.3.1.2 Field Surveying

The vegetation within and surrounding the Project Site, including within the alignment of the alternative route (Route Option 2) – see **Figure 3.12**) was mapped by Idyll Spaces at various times since 2005. Details of the vegetation mapping is presented in Idyll Spaces (2008). It was recognised by Idyll Spaces that the vegetation in the forested section of both alternate routes was very similar.

Apart from the mapping undertaken in 2005, other survey efforts included 20 hours in October 2005 (10 plots and 10 random meanders) for a previous study prior to installation of the existing gas wells (Idyll Spaces 2005), and 6 plots, associated random meanders and mapping of understorey habitat for Pilliga Mouse over 13 hours in May 2006 (Idyll Spaces 2006).

Further plot surveys were not undertaken because:

the routes were within 1.5km of each other;

the same floristic communities occurred on or adjoining both routes; and

the route was affected by drought and grazing at the time of both route surveys, and survey for ground layer species would be unlikely to have yielded any new information.

Overall survey effort meets or considerably exceeds that required under DECC survey guidelines for all areas except for cleared areas private property.

As a direct result of the field surveying carried out to date, three native communities have been identified as dominating PAL2 and hence the area covered by the Project Site. The communities are:

(i) *Corymbia trachyphloia-Eucalyptus dwyeri* Woodland;

(ii) *Eucalyptus crebra* Dry Open Forest; and

(iii) Pilliga Box *Eucalyptus pilligaensis* Dry Open Forest.

Figure 5.8 presents the locations of each of the three vegetation communities within the gas flow line corridor and **Table 5.14** summarises the structure and principal flora types within these vegetation communities.

The open agricultural lands between the East Pilliga State Forest and the Wilga Park Power Station is either improved pasture or cropping paddocks and has not been subject to a specific flora survey effort as there is no intention to modify or remove existing vegetation to facilitate the installation of the gas flow line. Furthermore, remnant native grassland species of conservation significance assessed as possibly occurring in the Study Area are not regarded as persistent under heavy grazing pressure and / or cultivation. The absence of a detailed flora

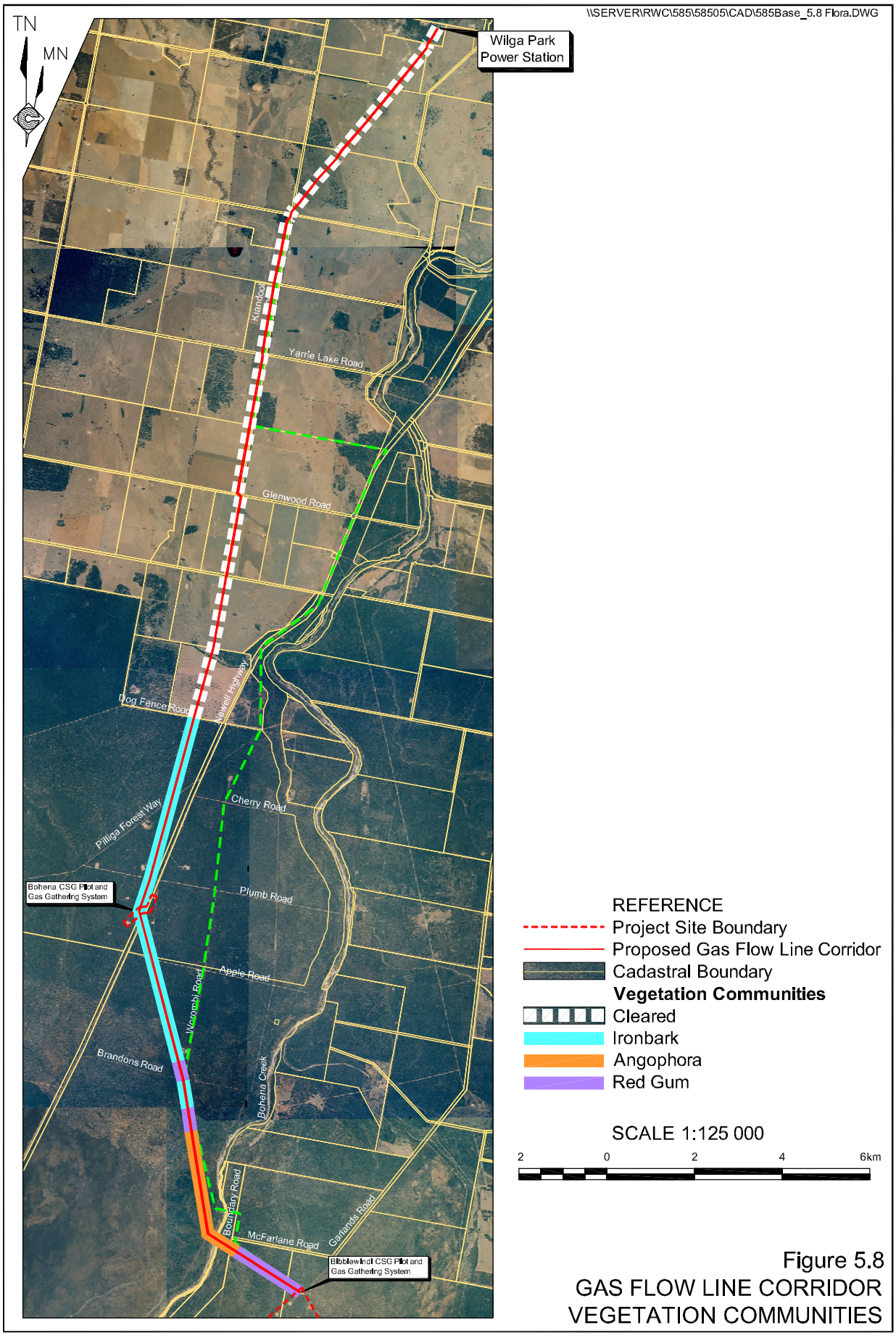


Figure 5.8
GAS FLOW LINE CORRIDOR
VEGETATION COMMUNITIES

Table 5.14
Summary of Dominant Vegetation Communities in the Project Site

Vegetation Community	Summary
Corymbia trachyphloia-Eucalyptus dwyeri Woodland,	Either or both Brown bloodwood & Dwyers Red Gum are present. Bloodwood dominates because of its taller stature; Dwyer red gum is typically 'mallee' in form. Midstratum includes *Allocasuarina gymnanthera, Aotus mollis, Brachyloma daphnoides, Calytrix tetragona, Dodonea peduncularis, Grevillea floribunda and Homoranthus flavescens*. Ground layer typically sparse with *Actinotus helianthii, Helichrysum collinum, Shoenus ericatorum* and various *Aristida spp*. Community is typically sparse & open, stands of bloodwood ≥20m and red gum to ≥15m. Mid density stands of heath shrubs or white cypress (scattered saplings). Ground layers typically sparse. Found in the Bibblewindi area on poor sandy soils with good drainage.
Eucalyptus crebra Dry Open Forest	Narrow leaved Ironbark is always present and usually dominant. Other common species include White pine *Callitris glaucophylla* and bull oak *Allocasuarina luehmannii*. Midstratum of hopbushes *Dodonea spp, Calytrix tetragona*, wattles *Acacia spp*, and broom bitter pea *Daviesia genistifolia*. Ground layer most diverse, with mat-rushes *Lomandra spp*, sawsedge *Gahnia aspera*, flax lily *Dianella longifolia*, wild onion *Bulbine semibarbata*, *Laxmannia gracilis*, *Calandrinia spp*, *Goodenia spp*, bluebells *Wahlenbergia spp*, cutleaf daisy *Brachycome multifida* and the fern *Cheilanthes austrotenuifolia* very common. Open stands of narrow leaved ironbark at around 20m tall with or without white cypress and bull oak over the midstratum with scattered stands or sparse individual sclerophyllous shrub. Sparse to mid-dense ground layer of forbs, grasses and graminoids. Community occurs on silty sand with adequate drainage.
Pilliga Box *Eucalyptus pilligaensis* Dry Open Forest	Pilliga box *Eucalyptus pilligaensis* is the dominant species, and Bull oak is common. White cypress and Narrowl eaved ironbark are less common. Mid stratum vegetation is very sparse or absent. Ground layer vegetation is dominated by grasses such as *Paspalidium distans* and *Eragrostis sterilis* elsewhere. Other common species include burr-daisy *Calotis cuneifolia*, bluebells *Wahlenbergia spp*, the grassy sedge *Carex inversa*, saw sedge *Gahnia aspera*, and mat-rushes *Lomandra spp*. This community typically consists of mature trees over occasional stands of coppice and dense regrowth and sparse grasses and forbs. This community occurs in the southern part of the Study Area, often on darker silty soils. No Threatened species were detected in this community in the Study Area. The community is potential habitat for the Threatened species *Diuris tricolor, Polygala linariifolia*, and *Rulingia procumbens.* This community is classified as Pilliga Outwash Dry Sclerophyll Forests (Keith 2004) or Type 193 White Cypress Pine – Box (Forestry Commission 1989). It is not listed as Endangered under the *TSC Act* or *EPBC Act*.

survey of the agricultural lands is not considered to be a limitation upon the flora assessment principally for the following reasons.

- The cleared parts of the northern section of the preferred route were affected by drought and very heavily grazed at the time of both surveys, and survey for ground layer species would have been ineffective.
- The cleared parts consisted of either improved pasture, or cropping paddocks with little native vegetation. Improved pastures contained a substantial component of exotic grasses and legumes and typically showed evidence of cultivation.
- Remnant native grassland species of conservation significance assessed as possibly occurring in the Study Area are not regarded as persistent under heavy grazing and/or cultivation. Native grasslands of the type listed in the

determination for 'Native Vegetation on Cracking Clay Soils of the Liverpool Plains' are not recorded as occurring, and not predicted to occur, in the Study Area(http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/cma_subregion_list.aspx?id=776).

- Elements of the Brigalow EEC present along the northern section of the preferred route consisted of isolated paddock trees of *Casuarina cristata* apparently retained for their fodder and shade value, and occasional clumps of *Acacia harpophylla* young coppice growth. The spacing between these remnant trees was generally considered adequate to allow installation of the pipeline with little or no impact on these trees.
- Other native vegetation along the preferred route consisted of isolated remnant eucalypts typical of Pilliga communities dominated by Grey Ironbark or Pilliga Box.
- Given the apparent effort by farmers to clear, improve and crop private lands in the northern part of the preferred corridor, as observed over the period of the pipeline project to date, further survey effort on private land was assessed as futile, or even counter-productive.
- In particular, the extent of the cropland, improved pasture and remnant tree habitats in the locality is so large in comparison to the small narrow area of similar habitat to be modified by the proposed pipeline that the proposed pipeline would not (for example) be likely to have an adverse effect on the life cycle of any species such that a viable local population of the species is likely to be placed at risk of extinction, or likely to have an adverse effect on the extent or composition of any ecological community such that its local occurrence is likely to be placed at risk of extinction, or have a significant impact on the extent to which habitat is likely to be removed or modified as a result of the action proposed, or cause habitat to become fragmented or isolated from other areas of habitat.

5.3.2 Potential Impacts

The potential Project-related impacts on vegetation relate principally to the modification and/or clearance of vegetation. The creation of the gas flow line corridor requires the removal of the bulk of the existing vegetation within a maximum 10m wide area within the gas flow line corridor and is therefore considered a finite impact that can be quantified.

Idyll Spaces (2008) indicates that the direct impacts of the Project on the vegetation of the Project Site are expected to equate to a loss of 13.1ha of existing native vegetation cover, of which 9.2ha would be a shorter term, temporary loss (where rehabilitation can be effected) and 3.9ha of longer term modification that would be maintained as such throughout the operational life of the flow line. **Table 5.15** summarises the calculated area of native vegetation clearance required on a community basis.

Table 5.15
Area of Native Vegetation Clearance Required on a Community Basis

Community	Length(km)	Width(m)	Cleared Area(ha)
Ironbark	7.6	10.0	7.6
Angophora	3.0	10.0	3.0
Red Gum	2.5	10.0	2.5
Total	**-**	**-**	**13.1**

5.3.3 Key Threatening Processes

The following section discusses the various key threatening processes that have been assessed given there is some potential they could occur during the construction of the Project. They have been summarised from the DECC information database on key threatening processes.

http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/pas_ktp.aspx

5.3.3.1 Key Threatening Process – Degradation of Native Riparian Vegetation

In 2001, the degradation of native vegetation along NSW rivers and streams was listed as a key threatening process under the *Fisheries Management Act 1994*.

Riparian vegetation forms an important part of a healthy functioning ecosystem and has numerous important ecological benefits. The value of riparian vegetation relates directly to the health and quality of rivers and water courses by stabilising river beds and banks, protecting against erosion and slumping.

The proposed gas flow line corridor intersects the riparian environment on the margins of Bohena Creek. The Project would require the modification/clearance of a 10m wide corridor through this environment to permit the installation of the gas flow line across the creek. The riparian zone is approximately 150m wide which would result in a cumulative total of 1.5ha of this area being modified to effect the installation of the flow line.

5.3.3.2 Invasion of Plant Communities by Exotic Perennial Grasses

The Invasion of native plant communities by exotic perennial grasses was listed as a Key Threatening Process on Schedule 3 of the *Threatened Species Conservation Act 1995* [12 September 2003].

Exotic perennial grasses of special concern include *Hyparrhenia hirta* (Coolatai grass), *Cortaderia* spp. (pampas grasses), *Sporobolus fertilis* (giant Parramatta grass), *Nassella neesiana* (Chilean needlegrass), *Nassella trichotoma* (serrated tussock) and *Eragrostis curvula* (African lovegrass).

The carrying of exotic perennial grass seeds and vegetative matter into the native forests of the Pilliga is of potential concern to the Project.

5.3.3.3 Clearing of Native Vegetation

Clearing of native vegetation was listed as a Key Threatening Process on Schedule 3 of the *Threatened Species Conservation Act 1995* [21 September 2001].

Clearing, as defined by the determination, refers to the destruction of a sufficient proportion of one or more strata (layers) within a stand or stands of native vegetation. There are numerous impacts as a result of clearing native vegetation, including:

- destruction of habitat causing a loss of biological diversity, and may result in total extinction of species or loss of local genotypes;
- fragmentation of populations resulting in limited gene flow between small isolated populations, reduced potential to adapt to environmental change and loss or severe modification of the interactions between species;
- riparian zone degradation, such as bank erosion leading to sedimentation that affects aquatic communities;
- disturbed habitat which may permit the establishment and spread of exotic species which may displace native species; and
- loss of leaf litter, removing habitat for a wide variety of vertebrates and invertebrates.

The Project requires the clearance or modification of a maximum of 13.1 ha of native vegetation.

5.3.3.4 Removal of Dead Wood and Dead Trees

Removal of dead wood and dead trees was listed as a key threatening process on Schedule 3 of the *Threatened Species Conservation Act 1995* [12 December 2003].

The "removal of dead wood and dead trees" includes: the removal of forest and woodland waste left after timber harvesting, collecting fallen timber for firewood, burning on site, mulching on site, the removal of fallen branches and litter as general tidying up, and the removal of standing dead trees.

Dead wood and dead trees provide essential habitat for a wide variety of native animals and are important to the functioning of many ecosystems. The removal of dead wood can have a range of environmental consequences, including the loss of habitat (as they often contain hollows used for shelter by animals), disruption of ecosystem process and soil erosion.

The forests and woodlands of the Western Slopes and Tablelands are the ecological communities most threatened by dead wood removal because they contain popular firewood species.

The Project presents some likely impact in terms of interfering with existing examples of dead wood and dead trees across the Project Site.

5.3.4 Mitigation of Potential Impacts

In order to minimise the impact of clearing on habitat for threatened species, endangered ecological communities and key threatening processes, it is proposed that:

- the clearing envelope within the gas flow line is marked before commencement of clearing, and movement of plant, machinery or materials beyond the clearing boundary is to be rigorously avoided;
- the clearance of native vegetation across all operational environments is to minimised to the greatest extent;
- the removal of dead wood and trees from and adjacent to the Project Site is to be rigorously avoided where possible. All dead wood/trees felled from within the disturbance corridor are to be retained and relocated; and
- the introduction of invasive exotic grasses and weeds is to be avoided by ensuring the strict observation of the published weeds management plan.

Weed Management

Without an appropriate mitigation strategy, there is moderate to high potential for weed species to be spread along the gas flow line corridor during the construction period. For the scope of this project, a weed is defined as being any plant species that is growing where it should not be and is not limited to noxious or declared weeds i.e. the weed management strategy would target both environmental and agricultural weeds.

- Environmental Weeds - environmental weeds are plants that represent a threat to the conservation values of natural ecosystems. They invade native plant communities and out-compete them causing a reduction in plant diversity and resulting in a loss of habitat for native animals. Some examples of environmental weeds are bridal creeper, bitou bush, boneseed, blackberry and lantana. Environmental weeds can also be native Australian plants that are not local (indigenous) to the area they are growing in. They have the potential to displace and out-compete plants within the local plant community. Examples of native Australian plants that are doing this are sweet pittosporum and coast wattle.
- Agricultural Weeds - Agricultural weeds are plants that represent a threat to agricultural production. They reduce the area available for agricultural activities, interfere with agricultural practices and affect the quality of produce. Some examples of agricultural weeds are serrated tussock, thistles, blue heliotrope, St John's wort, Paterson's curse and blackberry.

Weed transfer and infestation would be managed through the introduction of a weed management plan focussing on mitigation of a majority of the risk involved in large construction projects in the rural environment.

Weed Management Plan

The following mitigation actions would be implemented during the construction period to limit the risk that weed species or pathogens are transferred along the gas flow line corridor.

- Plant and vehicle hygiene standards would be maintained throughout the construction period to minimise the risk of weed and pathogen transfer.
- Plant and vehicle wash down would occur at the Proponent's maintenance depot on arrival in the Narrabri area or, for local contractors, prior to commencement of works. Wash down would focus on the removal of all soils, mud and vegetative matter.
- Plant and vehicle wash down would occur after exit from Forest and prior to entry onto pasture/cropping lands in a specified wash down bay with appropriate seed, vegetative material and sediment collection devices.
- Soils disturbed during stripping/stockpiling and trench spoil must remain at the point source as far as practicable. Any materials imported to the gas flow line corridor must be from landholder approved sources.
- Weed monitoring and control of weeds would occur during the construction period and on a regular basis during operations or as specified in individual land holder agreements.

Bushfire Hazard Management

The bushfire hazard associated with the construction and operation of the Project is closely related to the existing environment.

The majority of the southern section of the Project Site traverses light to moderately vegetated forestry lands of little discernible slope (0-3°) except for very close to the Bibblewindi CSG Pilot where gently sloping land is encountered. This section of the project site would be expected to exhibit moderate to high bushfire hazard mainly due to the extent of vegetation cover.

Much of the northern section of the Project Site has been cleared for agricultural activities and would be expected to exhibit a low bushfire hazard. However, vegetation remnants of varying densities are encountered where the gas flow line runs parallel to retained shelter belts and road easements.

The Project-related activities that may increase the risk of fire on the Project Site and the controls proposed to limit any such risk are presented in **Table 5.16**.

The Project would increase the number and type of ignition sources in the local area for the duration of the construction period, however, the proposed controls and safeguards would serve to ensure that a low bushfire hazard was maintained on the Project Site

Table 5.16
Summary of Possible Ignition Sources and Controls

Activity	Possible Ignition Source	Safeguards/Controls
General Activities	• Smoking/Cigarettes • Incidental ignition (glass/metal)	No smoking policy within the forested lands except in designated locations; Rubbish and waste management plans strictly enforced on all operational sites
Machinery Refuelling	• Ignition of fuels	All refuelling to occur in designated staging areas only All machinery to be switched off for refuelling No smoking on or near refuelling sites Fire extinguishers to be maintained on all operational sites and machinery

5.3.5 Assessment of Impacts

The proposed development would require the clearing of a 10m wide corridor to permit the access of trenching and pipe installation machinery for the duration of the construction activity. The extent of vegetation modification or clearance would vary with the changing land system to the north of the East Pilliga State Forest. The variations would include:

- the preparation of the easement within the light to heavily vegetated sections involving the clearing of all woody vegetation within the 10m wide easement reduced to a width of only 3m following rehabilitation for ongoing access and maintenance;
- where the easement is located upon previously cleared agricultural lands, no vegetation clearance is anticipated.

Idyll Spaces (2008) identifies that a total of 13.1 ha of native vegetation would be required to be modified or cleared in preparing the easement for the installation of the gas flow line.

Threatened Species Conservation Act – Assessment of Significance

Idyll Spaces (2008) assessed the nature and magnitude of impacts associated with the proposal in terms of the draft *Threatened Species Survey and Assessment Guidelines* (DEC, 2004) and considered the following.

- **Pre-construction, construction and occupation/maintenance phases**

  It is envisaged that construction would occur over a short period, and that occupation (for maintenance / inspection purposes) would continue for an indefinite period.

- **All on-site and off-site impacts, including location, installation, operation and maintenance of auxiliary infrastructure and fire management zones**

  On-site impacts would include the total loss of vegetation cover. No off-site impacts are expected.

- **All direct and indirect impacts**

  It is expected that direct impacts would be confined to the Project Site. Potential indirect impacts would be limited to introduction of new weed species into the Project Site from contaminated plant or machinery, if not appropriately controlled.

- **The frequency and duration of each known or likely impact/action**

  The construction impacts would occur as a single event over a comparatively short period. Ongoing impacts are likely to be limited to those associated with regular vehicle access for the purpose of maintenance and are likely to be similar to those arising from current land use as State Forest.

- **The total impact which can be attributed to that action over the entire geographic area affected, and over time**

  The total impact upon existing native vegetation which can be attributed to the Project would occupy 13.1ha, a small part of the 175ha Study Area and 127 500ha locality for an indefinite period not exceeding 50 years.

- **The sensitivity of the receiving environment**

  The numerous roads tracks and services occurring throughout the locality provide no evidence to indicate that the receiving environment would be unduly sensitive to the impacts of the Project.

- **The degree of confidence with which the impacts of the action are known and understood.**

  Activities of the type proposed have been undertaken over a long period and their impacts are relatively well known and understood.

Seven Part Tests for Threatened Species

Idyll Spaces (2008) conducted Seven Part Tests on threatened plant species according to growth form and habitat.

- Group 1 – *Lepdium ascheronii* (fertile clay soils).
- Group 2 – *Diuris tricolour, Polygala linariifolia, Rulingia procumbens* (woodland on sandy soils).
- Group 3 – *Bertya sp. Cobar-Coolabah*, *Philotheca ericifolia*, *Pterostylis cobarensis* (heath, mallee or woodland on stony, red or skeletal soils).

The following summary is based upon the full the complete seven part tests found on pages 19-24 of the Flora Assessment.

(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Group 1 - *Lepidium aschersonii*
The species was not detected in the Study Area. An apparently viable (reproducing) local population occurs in the Brigalow Park Nature Reserve approximately 5km west of the Study Area (northern section).

The Project would not require the clearing of any potential habitat for the species. The action proposed is assessed as not likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

Group 2 - *Diuris tricolor, Polygala linariifolia, Rulingia procumbens*
The species were not detected in the Study Area. No local populations of these species are recorded.

The Project would require the clearing of 7.6ha of potential habitat for the species. This habitat occurs in Ironbark and Pilliga Box communities, and is widespread and common in the Study Area, locality, and region. The life cycle of these species is unlikely to be dependent on or impacted by factors that may result from or operate within the narrow strips of vegetation, previously modified by forestry activities that would be removed by the proposal.

The Project is assessed as not likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

Group 3 - *Bertya sp. Cobar-Coolabah, Philotheca ericifolia, Pterostylis cobarensis*.
The species were not detected in the Study Area. A local populations of Bertya sp. Cobar Coolabah has been reported from an area of crown land adjacent to the Newell Highway and east of the Study Area.

The Project would require the clearing of 5.5ha of potential habitat for the species. This habitat occurs in Angophora and Red Gum communities, and is widespread and common in the Study Area, locality, and region. The life cycle of these species is unlikely to be dependent on or impacted by factors that may result from or operate within the narrow strips of vegetation, previously modified by forestry activities that would be removed by the proposal.

The Project is assessed as not likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Endangered populations as listed on Part 2 of Schedule 1 of the TSC Act do not occur in the Study Area or locality.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

The Endangered Ecological Community *Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions* occurs in the northern part of the Study Area.

The Project would not require the clearing of any of the community. Approximately 200ha of the community is reserved in the nearby Brigalow Park Nature Reserve. The Project is therefore assessed as not likely to have an adverse effect on the extent of the ecological community or adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

(d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed,

Assessment of the area and quality of habitat of the threatened species, population or ecological community that occurs within the locality;

Approximately 25 000ha of area mapped as the vegetation class 'Pilliga Outwash Dry Sclerophyll Forest >50%', 50 000ha of vegetation class 'Pilliga Outwash Dry Sclerophyll Forest 10% to 50%', 25 000ha of vegetation class 'Western Slopes Dry Sclerophyll Forest >50%' and a 25 000ha of 'Brigalow Clay Plain Woodland 1% to 10%' occur in the locality (http://maps.environment.nsw.gov.au/stateveg/).

The Dry Sclerophyll Forests occur mostly in large blocks of State Forest that have been extensively roaded and logged, and managed for timber production for over 100 years. They contain potential habitat for the threatened species *Bertya sp* Cobar Coolabah, *Diuris tricolor*, *Philotheca ericifolia*, *Polygala linifolia, Pterostylis cobarensis* and *Rulingia procumbens* . Of these only *Bertya sp* Cobar Coolabah is known to occur in the locality, in Jacks Creek State Forest with associated species including *Eucalyptus chloroclada* and *Eucalyptus fibrosa, neither of which were detected in the Study Area. The evidence suggests that the quality of habitat in the Study Area may not be suitable for these species.*

Brigalow Clay Plain Woodland occurs as small remnants in a largely cleared agricultural landscape. Remnants in the Study Area occur on road reserves and appear to have regrown following earlier clearing. They are subjected to some ongoing disturbance from road maintenance activities, rubbish dumping, and grazing. They are potential habitat for *Lepidium aschersonii*, which is recorded from a road reserve in the locality.

Assessment of the area and quality of habitats of the threatened species, population or ecological community that occurs within the Study Area;

Approximately 3ha of Brigalow and potential habitat for *Lepidium aschersonii* occurs in the Study Area. As the species is recorded from a road reserve in the locality, the quality of habitat in the Study Area may be adequate for the species.

Approximately 63ha of potential habitat for *Diuris tricolor, Polygala linariifolia,* and *Rulingia procumbens* occurs in the Study Area. These species have not been recorded in the locality and the quality of habitat in the Study Area may not be adequate for the species.

Approximately 35ha of habitat for *Bertya sp.* Cobar-Coolabah*, Philotheca ericifolia, Pterostylis cobarensis* occurs in the Study Area. Of these only *Bertya sp.* Cobar-Coolabah has been recorded in the locality, in association with eucalypts not detected in the Study Area, and the quality of habitat in the Study Area may not be adequate for the species.

Estimation of the area and quality that the habitat of the Study Area represents in relation to the local distribution of that habitat;

The vegetation of the Study Area represents between 1% and 0.1% of habitat for Group 1 (*Lepidium aschersonii*) and Brigalow in the locality.

It represents an estimated 0.2% of habitat for Group 2 (*Diuris tricolor, Polygala linariifolia, Rulingia procumbens)*, and 0.2% of habitat for Group 3 (*Bertya sp. Cobar-Coolabah, Philotheca ericifolia, Pterostylis cobarensis*).

Estimation of the area and quality of the habitat of the Study Area which is to be removed or modified by the proposed development, activity or action or indirectly by longer term impacts from the proposed development such as increased predation, weed invasion, salinity etc;

The area of habitat to be removed or modified by the Project is calculated at 13.1ha (**Table 3**). The quality of the habitat to be removed is typical of forest communities in the Pilliga. Recommendations made later in this report would minimise opportunities for indirect impacts such as weed invasion.

Estimation of the area and quality of the habitat of the region that would be removed or modified by the proposed development, activity or action;

No habitat for Group 1 would be removed or modified by the proposal.

Habitat for Group 2 that would be removed or modified by the proposal is calculated at 7.6ha, or 0.02% of similar habitat present in the region.

Habitat for Group 3 that would be removed or modified by the proposal is calculated at 5.5ha, or 0.02% of similar quality habitat present in the region.

Assessment of the ecological integrity of the habitat to be affected and of the habitat which would remain.

There habitat to remain is similar to the habitat to be affected.

(i) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action,

The small scale and spatial arrangement of the proposal is such that habitat is not likely to become fragmented or isolated from other areas of habitat.

(ii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,

The habitat to be removed is assessed as likely to be of little importance for the long-term survival of endangered ecological communities or threatened flora species in the locality.

(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

Critical habitat as listed in the Register of Critical Habitat kept by the Director General of Department of Environment and Conservation does not occur in the Study Area.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,

The Project is consistent with the objectives and actions of the *Bertya sp* Cobar Coolabah Recovery Plan (NPWS 2002). No recovery plans or threat abatement plans are currently listed for *Lepidium aschersonii, Diuris tricolor, Polygala linariifolia, Rulingia procumbens*, *Philotheca ericifolia,* or *Pterostylis cobarensis.*

(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The Project would involve the key threatening process 'Clearing of native vegetation'. It has the potential to contribute to the impact of 'Invasion of native plant communities by exotic perennial grasses'.

Clearing is one of the threats listed for *Bertya sp* Cobar Coolabah and *Philotheca ericifolia*. Similarly, weed invasion is listed as a threat for *Bertya sp* Cobar Coolabah and *Diuris tricolor*.

5.3.6 Conclusions

Given consideration of the above assessment, and in particular the small area of vegetation to be removed, both in absolute terms and in terms of the habitat for threatened species in the locality and region, and the apparent absence of threatened flora species from the Project Site and Study Area, it is concluded that a referral to the Federal Environment Minister would not be required.

Consideration of potential green offsets to account for the cumulative impacts of vegetation clearance and modification would occur as soon as practicable in consultation with Forestry NSW and DECC.

The mitigation of risk from weed infestation has been characterised and can be mitigated to a significant degree through the implementation of the weed management plan outlined in Section 5.3.4. No long term detrimental effects are expected to be realised on the basis of this weed management strategy.

5.4 Fauna

The fauna assessment was undertaken by Kendall and Kendall Ecological Consultants referred to hereafter as "Kendall". The assessment is presented in full as Part 3 of the *Specialist Consultant Studies Compendium* with the relevant information from the assessment summarised in the following subsections. The fauna assessment is referenced as Kendall and Kendall (2007).

5.4.1 The Existing Environment

5.4.1.1 Introduction

The Proponent engaged Kendall & Kendall Ecological Consultants to compile detailed fauna data across the Project Site and surrounds throughout three separate survey efforts over the 2005/2007 period.

The NSW DECC wildlife atlas identified the following eight threatened species as occurring within approximately 5km of the Study Area.

- Barking Owl.
- Speckled Warbler.
- Painted Honeyeater.
- Hooded Robin.
- Black Striped Wallaby.
- Brown Treecreeper.
- Glossy Black Cockatoo.
- Koala.

A search of the DECC threatened species database was used to determine other TSC Act threatened species that may occur in the locality or within the Study Area. The search parameters included the geographical subregions of the Namoi catchment, the Pilliga Outwash and Pilliga 'Part A' whose habitat includes various dry sclerophyll vegetation communities. 25 threatened fauna species fulfilling these search parameters were listed within the DEC wildlife database and are listed in Table 2 of the fauna assessment (Kendall & Kendall, 2007)

Additional database searches were completed on the (Cwth) *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) significant species register which provides information pertaining to the status of each species and the type of presence derived from modelled habitat and maps of species distribution. The search indicates that 22 significant species whose mapped habitat may occur within 110km of the Study Area from the Commonwealth protected matters search tool.

Further assessment of the possibility of occurrence is provided by the author; nine of the species are given NIL possibility of occurring within the 10km range of the Study Area, one unlikely, eight possible, one likely and two no response. The full listing of these species can be found in Table 3 of the fauna assessment (Kendall & Kendall, 2007).

The EPBC Act database search also included migratory avian species listed under the Japan-Australia and China-Australia Migratory Bird Agreements (JAMBA & CAMBA) and the Bonn Convention on the conservation of migratory species for which Australia is a range state.

Habitat Assessment

Based upon the flora assessment completed by Idyll Spaces during various surveys between 2005 and 2007, Kendall considered the vegetation community descriptions as providing an adequate description of habitat in the Study Area, ie. the area covering both the proposed and alternate gas flow line routes. The vegetation communities' identified by Idyll Spaces along both the proposed and alternate routes include:

- Brigalow *Acacia harpophylla* Low Open Forest;
- Narrow leaf Ironbark *Eucalyptus crebra* Dry Open Forest;
- Pilliga Box *Eucalyptus pilligaensis* Dry Open Forest;
- Rough-barked Apple *Angophora sp.* Dry Open Forest; and
- Red Gum *Eucalyptus dwyeri* Woodland.

These vegetation communities fall into two vegetation classes as described in Kendall and Kendall (2007) and include:

- Brigalow Clay Plain Woodlands for the Brigalow *Acacia harpophylla* Low Open Forest; and
- Pilliga Outwash Dry Sclerophyll Forests for the Ironbark, Pilliga Box, Rough-barked Apple and Red gum communities.

These vegetation classes are used in the DECC threatened species profiles to describe individual threatened species habitat pertaining to the Pilliga Outwash subregion of the Namoi catchment.

Other habitat attributes identified by Kendall during the survey effort include sheltering resources such as hollow-bearing trees and foraging resources such as *Allocasuarina gymnathera*, a known food tree for the glossy black cockatoo.

There are no natural, free standing bodies of water in the Study Area or caves, rock crevices or rock area habitats that would promote greater than incidental inhabitation by fauna species of interest.

The Study Area and proposed corridors for the GGS and gas flow line are narrow lineaments mainly surrounded a large naturally vegetated area i.e. Pilliga State Forest and as such the area is not considered a corridor but as a source. On the freehold agricultural land to the north of the East Pilliga State Forest in places the gasflow line corridor along more narrowly vegetated areas such as road reserves, these areas are considered to be wildlife corridors.

5.4.1.2 Terrestrial Survey Methodology

The majority of the field surveying for the Project occurred between 7 November and 13 November 2006 along the route now referred to as the "alternate route". However, data collected during previous surveying efforts has contributed to the methodology for the surveys of the proposed and alternate gas flow line routes.

A further field survey of approximately 8km of the forested section of the proposed route was undertaken as a targeted transect search for Threatened Species, and to confirm vegetation mapping, over 6 hours in October 2007. Inspection was also undertaken of part of the route adjoining the remnant Brigalow EEC community on the road reserve.

The main survey effort included:

- 20 tree mounted Elliot (B size) traps set over 4 nights;
- 100 ground placed Elliot traps set over 4 nights;
- 12 Pit Fall traps set over 4 nights;
- 8 cage traps set over 4 nights;
- 60 hair tubes set in pairs (one on the ground and one in a tree) set over ten nights;
- Koala scat searches;
- nocturnal call playbacks of the powerful owl (6 nights), masked owl (6 nights), barking owl (6 nights), yellow-bellied glider (5 nights), koala (4 nights) and squirrel glider (4 nights);
- spotlighting on 3 nights incorporating nocturnal herpetology searches;

- Anabat recording for microbats over 2 nights at three sites;
- harp traps set in 6 locations over two nights each;
- opportunistic identification of birds and bird calls;
- diurnal herpetology searches; and
- searching for sign of significant fauna.

Figure 5.9 displays the locations where the various fauna survey apparatus were deployed.

Most of the survey work was concentrated in two localities with a scaled down survey effort at a third location. These sites were chosen in an attempt to survey different habitat types not sampled during previous surveys. The sites included one towards the southern end of the proposed flow line on and near Bohena Creek, the second further north in the Ironbark and Pilliga Box vegetation community and a third in the road easement Brigalow habitat towards the north of the Study Area.

This assessment draws on the results of two other fauna surveys conducted for Eastern Star Gas in the northern Pilliga Forests. The details of survey methodologies for these assessments are provided in the separate reports.

Overall, the extent of the survey to describe the fauna habitats and fauna likely to frequent the Project Site is considered adequate for the assessment of fauna-related impacts. This conclusion is drawn given the maximum separation distance between the two route options is 1600m and the confirmation of comparable habitat along both route options.

5.4.1.3 Terrestrial Survey Results

In total, 106 fauna species were identified, comprising:

- 7 amphibian species;
- 7 reptile species;
- 69 bird species; and
- 23 mammal species of which two were recordings of probable microbat species, one was a probable macropod species and three were introduced species.

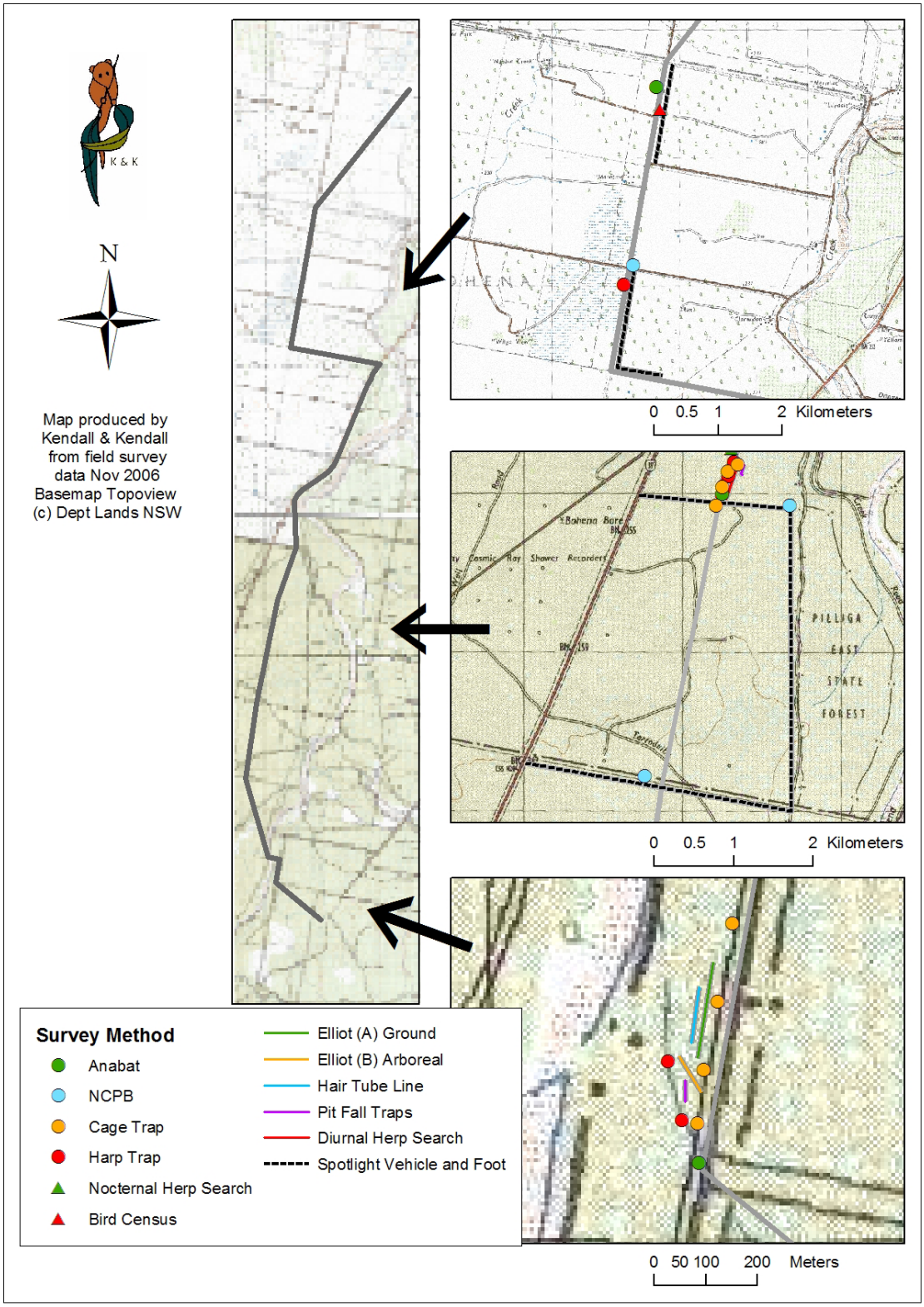
Also unidentified microbats were recorded by spot-lighting and ultrasonic bat call analysis.

Appendix 2 of the fauna assessment provides a list of all fauna species recorded on the Study Area. All relevant field data would be submitted to the DECC for inclusion in the wildlife atlas.

Threatened Species Records

A macropod scat was identified by Barbara Triggs, a recognised expert in this field, as a "probable" Black-striped Wallaby scat. This identification is consistent with the habitat in which the scat was found i.e. Brigalow. The Black-striped Wallaby is listed as endangered on Schedule 1 of the TSC Act.

Figure 5.9
Location of Fauna Survey Apparatus



The following threatened species listed as vulnerable on schedule 2 of the TSC Act were recorded during the field survey.

- Turquoise Parrot (*Neophema pulchella*).
- Barking Owl (*Ninox connivens*).
- Grey-crowned Babbler (*Pomatostomus temporalis*).
- Yellow-bellied Sheath-tail Bat (*Saccolaimus flaviventris*).
- Common Bent-wing Bat (*Miniopterus schreibersii*).
- Large-footed Mouse-eared Bat (probable) (*Myotis adversus/macropus*).
- Eastern Cave Bat (*Vespadelus troughtoni*).
- Little Pied Bat (Chalinolobus picatus).

The locations of all observations are recorded on **Figure 5.10**.

All microbats were recorded by bat call analysis conducted by Mr. Glen Hoye, a recognised expert in this field.

An unidentified long-eared bat was identified by bat call analysis; this call may have been an Eastern Long-eared Bat (*Nyctophilus timoriensis* (South-eastern form)) which is listed as vulnerable on Schedule 2 of the TSC Act 1995.

The migratory species provisions of the EPBC Act provide a list of all migratory bird species listed under international agreements and conventions. The birds on this list recorded during the field survey are:

- Wood Duck (*Chenonetta jubata*);
- Brown Falcon (*Falco berigora*);
- Rainbow Bee-eater (*Merops ornatus*); and
- Cicardabird (*Coracina tenuirostris*).

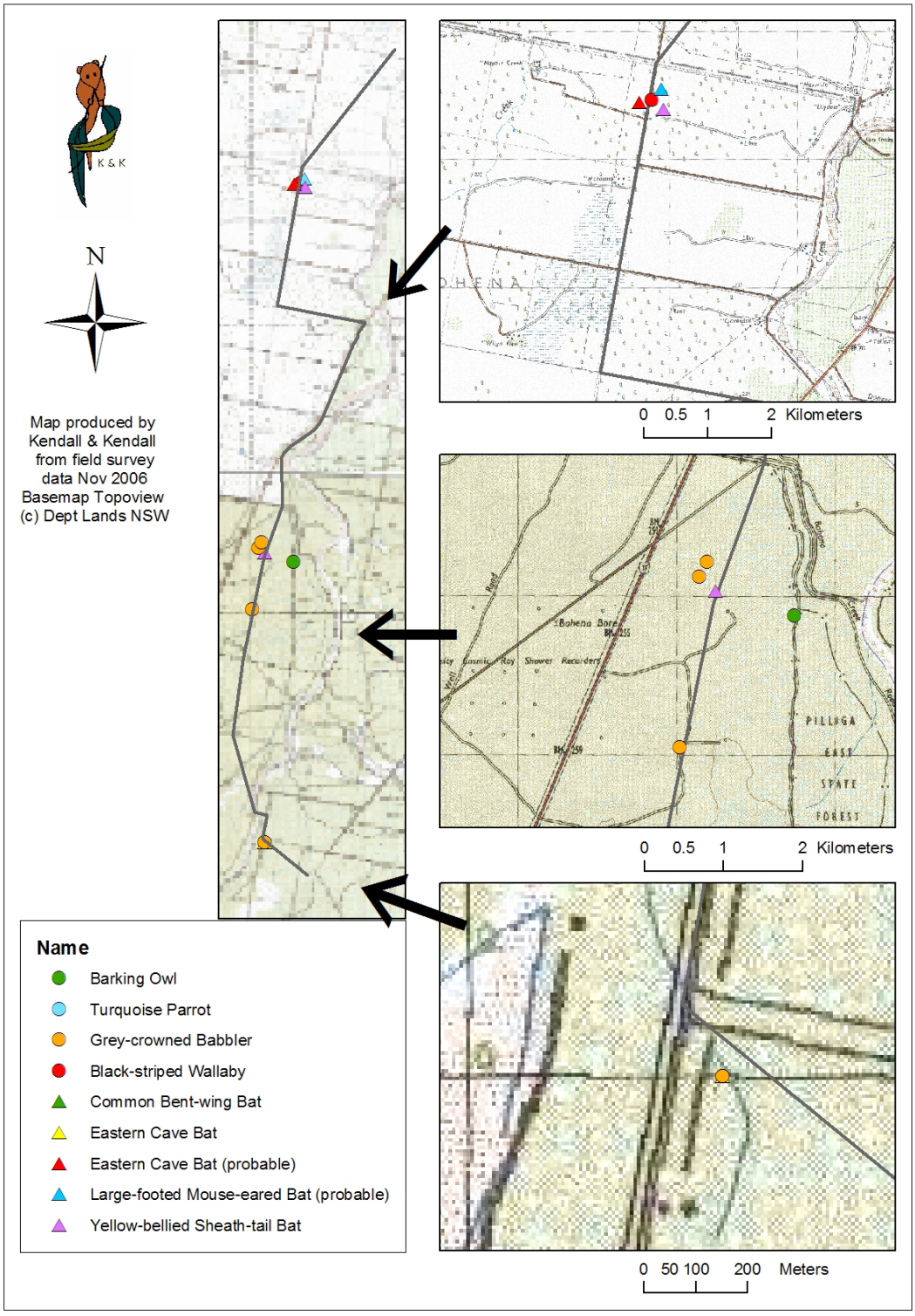
5.4.1.4 Threatened Species, Populations, EEC's or Critical Habitat

The fauna assessment records a number of TSC Act threatened species that occur within the Project Site including species listed as vulnerable on schedule 2 of the TSC Act. The study also identified the "probable" recording of the Black-striped Wallaby a species listed as endangered on schedule 1 of the TSC Act 1995. Seven Part Tests have been prepared for these species which assess the impact of the proposal on these species.

No critical habitat listed in recovery plans occurs on the Study Area.

No threatened ecological fauna communities or fauna populations listed on the schedules of the TSC Act occur on the Study Area.

Figure 5.10
Location of Threatened Species Observations During the Survey Effort



5.4.2 Potential Impacts

The linear and narrow nature of the project lowers the impact of habitat removal on fauna populations, however, it is recognised that there may be some disturbance to important habitat features such as hollow-bearing trees and logs on the ground. Further, it is important that the risks posed to fauna by the open trench during the installation period are minimised. For these reasons, the following ameliorative measures would be adopted.

5.4.3 Mitigation of Potential Impacts

The following ameliorative measures are based on a three tier hierarchy of:

- avoiding impact;
- minimising impact; and
- mitigating against impact.

The ameliorative measures have been developed from those:

- described by Smith (2002);
- management actions recommended on the DECC threatened species websites; and
- other measures identified by Kendall after conducting the field survey.

The following ameliorative measures would be adopted.

- Where possible, positioning the corridors selecting the location of the flow line to avoid hollow-bearing trees.
- Conducting pre-felling surveys of any trees with hollows that cannot be avoided.
- If the felling of a standing dead tree with hollows is necessary the tree should be first surveyed for the presence of resident fauna at dusk and either:
  - felled only after resident fauna have departed; or
  - felled during the day in a "soft manner" by using hay bales to lessen the impact of trees falling on the ground, hollows should then be inspected for fauna.
- If uninjured fauna are recovered from felled trees they should be released into adjoining suitable habitat at dusk on the following evening.
- If fauna are injured as a result of the tree felling they should be placed in the care of a local vet prior to being care for by a suitably experienced wildlife carer prior to release in adjoining habitat from where they were collected.

- Immediately prior to clearing all areas to be cleared should be searched for the presence of fauna, fauna found should be relocated to adjoining habitat. Areas searched should include places such as under logs and peeling bark.
- A qualified and experienced fauna ecologist should be present during the initial stages of work to ensure that correct procedures are followed, any unforeseen outcomes are addressed and to clarify any areas of operation uncertainty not covered by these protocols.
- Inspecting all trees to be removed for the presence of bird of prey nests especially near Bohena Creek and avoiding disturbance to that tree if a nest is located.
- Inform drivers of vehicles of the possibility of a range of fauna they may at times cross access roads emphasising the need to take care and slow down especially at dawn, dusk and during the evenings.
- A fauna management (open trench) procedure would be adopted to both limit the risks of small animals falling into the trench during the short period it is open and to recover any animals that inadvertently fall into the trench. This procedure would involve the following.
  - The operational zone, and hence length of open trench, would be minimised to the smallest length possible.
  - The period over which any part of the trench remains open would be limited to the smallest timeframe practicable.
- Fauna ramps would be placed in the trench (max 250m intervals) at the completion of each day shift where the trench would remain open overnight.
- At the commencement of each day shift, a visual inspection of the open trench by qualified and / or appropriately trained person/s would occur to locate any fauna that has fallen into the trench and assist in its relocation off the working area.
- Where the trench is to remain open for extended periods throughout the day time, additional inspections would be scheduled and fauna refuge devices placed within the open trench to provide shelter.

5.4.4 Assessment of Impacts

Habitat Modification or Removal

Direct impacts to fauna species by the Project, would include loss of existing native vegetation cover. The proposed activities are not expected to impact on landforms or drainage, or cause erosion, or adversely affect fire regimes in the locality (Idyll Spaces 2008). The clearing may require the removal of hollow-bearing trees which could impact on individual threatened species, also disturbance to the deep cracking soils in the northern section of the Study Area could impact on potentially occurring individual specimens of the Five-Clawed Snake-skink.

Impacts on Native Fauna

The linear and narrow nature of the project lowers the impact of habitat removal on fauna populations, however, it is recognised that there may be some disturbance to important habitat features such as hollow-bearing trees and logs on the ground for this reason ameliorative measures have been proposed as detailed below.

TSC Act – Assessment of Significance

Assessment of the nature and magnitude of impacts of the proposal follows the draft Assessment Guidelines (DEC 2004) and includes the following considerations as described by Idyll Spaces (2008) as the direct impact can be related to vegetation removal.

- **Pre-construction, construction and occupation/maintenance phases**

  Construction and installation would occur over a short period, and that occupation would continue for an indefinite period.

- **All on-site and off-site impacts, including location, installation, operation and maintenance of auxiliary infrastructure and fire management zones**

  On-site impacts would include the total loss of vegetation cover over a 13.1ha area. No off-site impacts are expected.

- **All direct and indirect impacts**

  It is expected that direct impacts would be confined to the Project Site, with potentially indirect impacts limited to introduction of new weed species into the Project Site from contaminated plant or machinery, if appropriate controls are not adopted.

- **The frequency and duration of each known or likely impact/action**

  The construction impacts would occur as a single event over a short period. Ongoing impacts are likely to be limited to those associated with regular vehicle access for the purpose of maintenance and are likely to be similar to those arising from current land use as State Forest.

- **The total impact which can be attributed to that action over the entire geographic area affected, and over time**

  The total impact which can be attributed to the proposal would occupy 13.1ha, a small part of the 175ha Study Area and 127 500ha locality for an indefinite period not exceeding 50 years.

- **The sensitivity of the receiving environment**

  The numerous roads tracks and services occurring throughout the locality provide no evidence to indicate that the receiving environment would be unduly sensitive to the impacts of the proposal.

- **The degree of confidence with which the impacts of the action are known and understood**

  Activities of the type proposed have been undertaken over a long period and their impacts are relatively well known and understood.

Activities of the type proposed have been undertaken over a long period and their impacts are relatively well known and understood.

The TSC Act assessment of significance outlines factors to be considered when determining whether an action, development or activity is likely to significantly affect threatened species, populations or ecological communities or their habitats (known as the 7 part test).

Seven Part Tests for Threatened Species

Seven-part tests for TSC Act threatened species known to occur on the Study Area or considered possible or likely to occur in the Study Area include:

- Five-clawed Snake-skink;
- Pale-headed Snake;
- Bush Stone-curlew;
- Grey Falcon;
- Black-breasted Buzzard;
- Square-tail Kite;
- Barking Owl;
- Masked Owl;
- Diamond Firetail;
- Rufous Bettong;
- Black-stripped Wallaby;
- Eastern-pygmy Possum;
- Squirrel Glider;
- Koala.
- Glossy-black cockatoo;
- Turquoise Parrot;
- Gilbert's Whistler;
- Hooded Robin;
- Grey-crowned Babbler;
- Speckled Warbler;
- Painted Honeyeater;
- Black-chinned Honeyeater;
- Spotted-tail Quoll;
- Pilliga Mouse;
- Little Pied Bat;
- Greater Long-eared Bat;
- Yellow-bellied Sheathtail-bat; and

The seven part tests have been prepared for groups of species with similar habitats and can be found in Appendix 7 of the fauna assessment (Kendall & Kendall, 2007).

EPBC Act Matters and Assessment

A search of the DEWR EPBC Act Protected Matters Report conducted on 20 February 2006 indicated that there are no world heritage properties, no national heritage places, no wetlands of international significance (RAMSAR Sites) or any threatened ecological communities known or predicted to occur within 10km of the Study Area. However, the search is not comprehensive and other migratory species covered by the provisions of the EPBC Act are discussed below. As the Study Area may provide habitat for some EPBC Act threatened and or migratory species an assessment of the significance of the potential impact of the project on these species using the administrative guidelines is provided in the following subsections.

In regard to other requirements of the EPBC Act it can be stated that the project would not affect a Commonwealth marine area and is not a nuclear action.

Impact on EPBC Act Threatened Species

The guidelines to the EPBC Act utilise eight tests to examine whether an action has, would have, or is likely to have a significant impact on a federally listed endangered or vulnerable species, and therefore whether the action would need to be referred to the Commonwealth Environment Minister.

No threatened species listed under the provisions of the EPBC Act were definitely recorded on the Study Area during the field survey. An unidentified long-eared bat was identified by bat call analysis; this call may have been the Eastern Long-eared Bat (*Nyctophilus timoriensis* South-eastern form) which is listed as vulnerable on the provisions of the EPBC Act 1999.

(a) Does, would, or is the activity likely to lead to a long-term decrease in the size of a population/ *important population*?

It is considered unlikely that due to the narrow linear nature of the habitat to be removed that the activity would lead to a long-term decrease in the size of a potentially occurring population/ important population.

(b) Does, would, or is the activity likely to reduce the area of occupancy of the species/*important population*?

It is considered unlikely that due to the narrow linear nature of the habitat to be removed that the activity is likely to reduce the area of occupancy of a potentially occurring species/*important population*.

(c) Does, would, or is the activity likely to fragment an existing population/*important population* into two or more populations?

It is considered unlikely that due to the narrow linear nature of the habitat to be removed that the activity is likely to fragment an existing population/*important population* into two or more populations.

(d) Does, would, or is the activity likely to adversely affect habitat critical to the survival of a species?

The Study Area does contain tree hollows which a potential sheltering and breeding resource for some potentially occurring EPBC Act threatened species, however as tree hollows are plentiful in the locality and if the proposed ameliorative measures are implemented the activity is unlikely to adversely affect habitat critical to the survival of a potentially occurring species.

(e) Does, would, or is the activity likely to disrupt the breeding cycle of a population/*important population*?

The Study Area does contain tree hollows which a potential breeding resource for some potentially occurring EPBC Act threatened species, however as tree hollows are plentiful in the locality and if the proposed ameliorative measures are implemented the activity is unlikely to adversely affect habitat critical to the survival of a potentially occurring species.

(f) Does, would, or is the activity likely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

It is considered unlikely that due to the narrow linear nature and small area of habitat to be removed compared to the area to be retained in the locality it is considered the project would not further modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that an EPBC Act threatened species considered possible to occur on the Study Area is likely to decline.

(g) Does, would, or is the activity likely to result in invasive species that are harmful to endangered/*vulnerable* species becoming established in the endangered/*vulnerable* species' habitat?

The proposal is unlikely to result in invasive species that is harmful to endangered/*vulnerable* species becoming established in the endangered/*vulnerable* species' habitat.

(h) Does, would, or is the activity likely to interfere with the recovery of the species?

The proposal is unlikely to interfere with the recovery of a potentially occurring EPBC Act threatened species.

Impact on EPBC Act Migratory Species

Migratory species listed in Appendix 5 of the fauna assessment (Kendall, 2007) can be identified as occurring in two groups, the first being those species for which the Study Area or surrounding area may provide suitable habitat, and those species for which the Study Area or nearby area does not provide suitable habitat. The first group can be further divided into:

- non-breeding migrant aerial insectivores from Asia eg White-throated Needletails;
- resident birds of prey that are wide-ranging at low density, with relatively large foraging ranges, and likely to use open areas eg Birds of Prey; and
- small birds likely to breed in habitats of the Study Area eg Rainbow Bee-eater (riparian sand banks and other open sandy areas).

The guidelines to the EPBC Act also utilise the following tests to examine whether an action has, would have, or is likely to have a significant impact on a terrestrial migratory species listed under the provisions of the EPBC Act.

(a) Does, would, or is the activity likely to substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat of the migratory species?

No. As the Study Area does not provide important habitat for a EPBC Act migratory species the proposal is unlikely to substantially further modify, destroy or isolate an area of important habitat of any of the migratory species considered as possible occurrences in the Study Area.

(b) Does, would, or is the activity likely to result in invasive species that is harmful to the migratory species becoming established* in an area of important habitat of the migratory species?

No. The Project is not of the type that is likely to result in invasive species that is harmful to the migratory species becoming established in an area of important habitat of the migratory species.

(c) Does, would, or is the activity likely to seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of the species?

No. As the Study Area does not contain important habitat for the migratory species the Project is unlikely to disrupt their lifecycles.

Aquatic

The proposal carries no potential for direct or indirect impact on aquatic species, ecological communities or habitat.

The creek is naturally ephemeral in its style, and has not contained any visible or measurable base flows since December 2004. There are no permanent or temporary pools within the impacted reach with any potential to contain aquatic species.

The presence of endangered or vulnerable species within the Namoi River/Barwon-Darling Rivers catchment is incidental to the contribution Bohena Creek offers to the river system. The proposal presents no threat to the ongoing management of the endangered species inhabiting the system or threat to the recovery plans currently being implemented by Fisheries NSW.

The ephemeral nature of Bohena Creek and the lack of measurable or visible base flows limit significantly the ability of the creek system to support any habitation by aquatic species. The geomorphologic characteristics of the creek system and its flow regimes do not support any aquatic species and the potential for aquatic fauna to migrate upstream from the confluence with the Namoi River is similarly absent due to the lack of permanent or semi permanent passage across the floodplains at the northern extremity of Bohena Creek.

The installation of the gas flow line into the sand bed well below the surface of Bohena Creek carries no measurable or incidental likelihood of blocking the passage of fish up or downstream of its intersection with Bohena Creek.

5.4.5 Conclusions

It is concluded that application of the seven-part test and administrative guidelines indicate that the Project would not have a significant impact on threatened fauna species, populations or endangered communities, or their habitats, or critical habitat, and that referral to the Federal Environment Minister would not be required.

5.5 Soils and Land Capability / Suitability

5.5.1 Introduction

The soil materials within both the proposed and alternate gas flow line corridors were assessed by Geoff Cunningham Natural Resource Consultants (GCNRC, 2008) with the aim of providing soils, land capability and agricultural land suitability information for those areas proposed to be disturbed within the corridors. The Study Area for this soil and land capability survey is a corridor approximately 20m wide along the length of the proposed and alternative route.

The soils assessment is included in full as Part 4 of the *Specialist Consultant Studies Compendium*.

The report was required to include sufficient level of detail in relation to prevention of land degradation during construction of the flow line and the rehabilitation / stabilisation of the soils along the route after construction. The report describes the soils based upon thirty nine representative soil profiles as well as laboratory analyses of a selection of representative profiles and land capability of the Project Site.

5.5.2 Soil Categories

The soil survey identified a mosaic of four Soil Mapping Units (SMUs) within the proposed gas flow line corridors as summarised in **Table 5.16**.

- **Soil Mapping Unit 1** – Deep Sandy Soils
- **Soil Mapping Unit 2** – Duplex Soils
- **Soil Mapping Unit 3** – Gilgai Soils
- **Soil Mapping Unit 4** – Brigalow and Clay Soils where Brigalow formerly existed

Table 5.16
Summary of Soil Mapping Units within the Proposed Gas Flow Pipeline Corridors

Soil Mapping Unit	General	Topsoil	Subsoil
1 – Deep Sandy Soils	Soil excavated to 120-160cm depth; surface condition soft, loose or firm; surface stone absent.	*Horizons*: A or A1 and A2. Texture: clayey sand; to sandy loam. pH: 4.5 to 6.0 Colour: brown; dark yellowish brown; light brown; reddish yellow; strong brown: or yellowish brown	Horizons: up to 3 B horizons. Texture: - sandy loam or clayey sand, sandy clay loam or light clay; cemented clayey sand. pH: 4.5 to 6.0 Colour: pale brown, pale yellow, very pale brown, brown, yellowish brown
2 – Duplex Soils	Soil excavated to 120-152cm depth; surface condition loose, soft, firm or rarely hardsetting; surface stone absent	*Horizons:* A1 and A2. *Texture:* sand, clayey sand, sandy loam, fine sandy clay loam, sandy clay loam, clay loam, silty clay loam; sandy. *pH:* 4.5 to 6.0 *Colour:* shades of brown	*Horizons:* up to 3 B horizons. *Texture*: silty clay, sandy light clay, light clay, light to medium clay [sometimes gritty], medium clay, heavy clay. *pH:* usually 4.0 to 7.5 or 8. to 9.5 to 10 *Colour:* shades of brown
3 – Gilgai Soils (i) – Gilgai Shelf	Soil excavated to 110 to 180cm depth; level plain location; gilgai shelf and puff surface condition cracked, self mulching; surface stone absent	*Horizons:* A horizon *Texture:* medium clay, medium to heavy clay. *pH*: 5.5 to 6.0 *Colour*: dark grey, dark greyish brown, black	*Horizons:* 2 B horizons. *Texture:* medium to heavy clay or heavy clay. *pH*: 5.5 to 9. *Colour*: very dark grey, greyish brown, very dark grey.
(ii) – Gilgai Puff	See above	*Horizons:* A horizon *Texture:* medium to heavy clay. *pH*: 6.0 *Colour*: dark grey, dark brown, black	*Horizons:* 2 B horizons. *Texture:* light to medium clay, heavy clay. *pH*: 5.5 to 9. *Colour*: very dark grey, dark greyish brown dry, very dark grey, dark greyish brown.
4 - Brigalow and Clay Soils Where Brigalow Formerly Existed	Soil excavated to 134-141cm depth; surface condition loose to firm, hardsetting and cracked or cracked and self-mulching; surface stone absent	*Horizon*: A horizon. *Texture*: silty clay loam / clay loam; light to medium clay; medium clay; medium to heavy clay, heavy clay. *pH:* 8 to 8.5 Colour: dark grey, dark greyish brown, very dark grey, dark brown.	*Horizon*: up to 3 B Horizons. *Texture*: light clay; light to medium clay; medium clay or heavy clay; *pH*: occasionally 4.5, usually pH 7.5 to 9.5 to 10. *Colour*: brown, strong brown, greyish brown, reddish brown
Source: Modified after GCNRC (2008) – Section 5.			

Not all soil layers described for each of the Soil Mapping Units are present in every profile. Soils are inherently variable in nature and while they may have similar overall characteristics they may vary in layer detail and properties.

5.5.3 Soil Properties

5.5.3.1 Physical and Chemical Attributes

Soil Laboratory Analyses

Fifteen samples from six soil profiles were selected for laboratory analysis at the Soil and Water laboratory of the Department of Lands at Scone.

The tests performed aimed at assessing the potential erodibility of the soils [Particle Size Analysis [PSA], Dispersion % [D%] and Emerson Aggregate Test [EAT] and Electrical Conductivity [EC].

Particle Size

The Particle Size Analysis [PSA] test shows the amounts of gravel, clay, silt, fine sand and coarse sand contained within each sample. Results contained in the report (GCNRC, 2008) indicate that most soils analysed contain relatively negligible levels of gravel.

The texture class of each soil layer is determined by analysis of the material [fine earth fraction] that is less than 2mm in size – i.e. the sample from each tested horizon with the gravel removed. The field textures of almost all layers of the 63 profiles that were examined indicated that the soils were generally more clayey than was shown in the laboratory analyses.

Dispersion

The Dispersion Percentage [D%] test indicates the proportion of the soil material less than 0.005 mm in size (i.e. the clay and some of the silt fractions) that may disperse on wetting.

The D% values presented in the soils report (GCNRC, 2008) indicate that:

- the topsoils **of all four SMUs** showed negligible to slight dispersibility;
- the subsoil of SMU 1 showed **slight** dispersibility;
- the subsoil of SMU 2 showed **very high** dispersibility;
- the subsoils of SMU 3 showed **very high** dispersibility; and
- the subsoil of SMU 4 showed **moderate** dispersibility.

Many of the subsoils contain moderate to high levels of clay and this makes them more dispersive than the analyses indicate. Given these indications of dispersibility, the erosion potential is undoubtedly high for all areas of exposed subsoil.

Consequently, appropriate measures need to be taken to protect the stockpiles of stripped subsoil during construction. The subsoils should then be placed in the excavated trench as soon as possible after pipe laying. Caution should be exercised to ensure that soil profile inversion does not occur.

Emerson Aggregate Test

The Emerson Aggregate Test (EAT) provides a measure of the coherence of soil aggregates when they are immersed in water.

The results from the EAT (Table 2. GCNRC, 2008) indicate that:

- the topsoils **of all four SMUs** showed negligible to slight dispersibility;
- the subsoil of SMU 1 showed **slight** dispersibility;

- the subsoil of SMU 2 showed **high to very high** dispersibility;
- the subsoils of SMU 3 showed **moderate to high to very high** dispersibility; and
- the subsoil of SMU 4 showed **moderate to high** dispersibility.

The dispersibility of the subsoils of SMUs 2, 3 and 4 makes it essential that any exposed subsoil and subsoil stockpiles are adequately protected from soil erosion at all times and are replaced in the excavated trench as soon as possible after pipe laying.

Linear Shrinkage

Linear shrinkage is the percentage decrease in the length of a bar of soil dried in an oven from the liquid limit and is assessed on a disturbed soil sample. The linear shrinkage percentage provides an indication of the likely impacts of soil shrinking and swelling on the proposed gas flow line

Linear shrinkage measurements were made in the laboratory for representative profiles from SMUs 3 and 4. The remaining SMU 1 and SMU 2 soils were not tested.

The laboratory results indicate that the soils tested have medium linear shrinkage potential. This issue should be addressed at the design stage by suitably qualified gas flow line designers to ensure that the flow line specifications are such that the walls are able to cope with the medium shrink – swell characteristics of the soil.

Chemical Attributes

Laboratory testing of the samples extended only to an examination of the electrical conductivity. Soil pH was measured in the field using the Raupach method.

Soil pH

In general, the pH [water] range in most soils is between 4.0 and 8.5 although pH values above and below this range are measured at times. This range of soil pH levels is generally accepted as being one that is suitable for plant growth. The pH 6.0 to 6.5 range is usually regarded as the optimum for growth of most plants and there are some more serious impacts on the growth of many species at the lower, or acid, end of the range. As the pH scale [between 0 and 14] is a logarithmic one, a soil with a pH of 5.0 is ten times as acid as a soil of pH 6.0 and 100 times as acid as one with a pH of 7.0.

The results presented in the pH column in Table 6 (GCNRC, 2008) indicates that all of the topsoils and almost all of the samples tested showed pH levels within the 4.0 to 8.5 range. Some of the lower layers in some SMUs were very alkaline and outside the range acceptable for plant growth, while in others the lowest horizons were relatively acid.

There should not be any problems associated with soil pH associated with the Project if the subsoil material is re-placed in the excavated trench before the topsoil material.

Electrical Conductivity

Soil salinity is a measure of the presence of water-soluble salts, mainly of sodium, calcium and magnesium in the soil solution. These salts may be chlorides, sulphates or carbonates and can have a major impact on plant growth if they occur in sufficiently large quantities. The level of salinity in a soil sample is determined by measuring the electrical conductivity [EC] of a 1:5 soil / water suspension.
The results in Table 8 (GCNRC, 2008) indicate that:

- topsoil materials from **all SMUs** are non-saline;
- the subsoils of **SMUs 1, 2 and 4** profiles were non-saline or slightly saline;
- the subsoils of **SMU 3** profiles contained horizons that varied in salinity from slight to moderate to moderately saline.

Soil salinity should not be a problem during the project if there is no profile inversion and the subsoil is re-placed in the excavated trench as soon as possible after pipe laying is complete.

Erosion Potential

The soils within the Project Site are currently generally stable since the most sloping areas are those within the State Forests support a generally good cover of litter, groundcovers, shrubs and trees. Some sections in the north of the proposed flow line route are cleared and cultivated and generally level [except for gilgai areas and areas that are not cleared].

Within the State Forests the relatively sandy nature of the topsoils and the presence of duplex soil profiles – along with the higher dispersibility of these soils – dictates that water erosion control measures should be constructed as soon as possible after rehabilitation are complete. Some areas may require special protection during construction to prevent soil loss in drainage lines and the like.

It would be essential, if erosion is to be prevented, to maintain an adequate groundcover on the existing landscape and on the reformed landscapes after rehabilitation work is carried out.

Soil Erodibility

An appropriate method of assessing the erosion hazard associated with the soils of the Study Area is to use the SOILOSS computer program that computes soil loss values for a given site under various land uses and climatic [rainfall] conditions and so provides an indication of erosion hazard.

In using SOILOSS, the rainfall erosion factor is obtained from maps provided with the program manual. Soil erodibility is either estimated from details of the soil type and soil surface texture by comparison with a table of soils presented by the program or is derived from knowledge of soil particle size analysis, organic matter content, surface soil structure and profile permeability. Slope length and steepness factors are derived from field measurements and / or examination of topographic maps or air photos.

The support practice factor is estimated by the program from a description of the land management practices in use, details of cultivation direction and information on bank systems if these are present.

The soils from all SMUs were allotted a LOW erodibility by the SOILOSS model based on their physical characteristics. Despite the LOW erodibility, as assessed by the SOILOSS analysis and field observations, the soils of all SMUs should be managed carefully during the stripping and rehabilitation stages to ensure that soil structure damage is minimal and that they are suitably protected by vegetation or some other medium after rehabilitation.

If the pipe laying process is delayed for any reason, it may be necessary to hydroseed the windrows of topsoil and subsoil to protect them from erosion. The length of open trench should be limited at all times with the line clearing and trenching being no more than a few days in front of the pipe layers and rehabilitation teams

5.5.3.2 Stripping Suitability of Soil Materials

GCNRC (2008) provides soil stripping recommendations for all SMUs identified within the gas flow line corridor as the nature of the project dictates that the stripping process would be linear and that a variety of soil materials would be encountered along the route.

Stripping and windrowing would ensure that topsoil and subsoil materials are stored in separate windrows on opposite sides of the trench and that the appropriate material would be replaced in the trench at a position very close to where they originated.

Perusal of the topsoil depth data from all profiles in all SMUs indicates that removal of a top layer of material 15cm deep would ensure that more fertile topsoil material with its accumulated seed bank would be readily available for rehabilitation. Topsoil should only be removed from the immediate vicinity of the trench where subsoil excavation is to occur. The topsoil and subsoil material would not be mixed and should be placed on opposite sides of the trench.

The subsoil should only be removed from the trench. The topsoil should always be placed on the same side of the trench [e.g. the western side] to avoid operator error during rehabilitation. The same procedure should apply for subsoils.

Profile inversion would be strictly avoided. The dispersibility of many of the subsoils may well result in soil erosion that exposes the buried flow line in wet periods if profile inversion occurs.

It is recognised that construction of a flow line requires many vehicles to travel along the trench line. However, given the relative fragility of the sandy soils in SMUs 1 and 2, the Proponent would endeavour to limit the amount of traffic along the flow line route and use existing intersecting roads and tracks as access as much as possible.

5.5.4 Land Capability and Agricultural Land Suitability

The 1: 100 000 scale Land Capability maps of the Baan Baa and Narrabri map sheet area prepared by the former Soil Conservation Service of NSW [DECC, Parramatta - GIS] shows that the sections of the proposed flow line route within Bibblewindi and Pilliga East State Forests have not been given a land capability classification.

Most of the remaining lands have been mapped as Class II and Class IV land with parts of the eastern route alternative near Bohena Creek being classified as Class V land. Areas of gilgai country and an area just north of Pilliga East State Forest, on the proposed corridor have been mapped as Class VI land.

Class II land is *land suitable for regular cultivation but requiring use of soil conservation practices such as strip cropping, conservation tillage and adequate crop rotation.*

Class IV land *is land not capable of being regularly cultivated but suitable for grazing with occasional cultivation and requiring soil conservation practices such as pasture improvement, application of fertilizer and minimal cultivation for the establishment or re-establishment of permanent pasture*.

Class V land *is land suitable for grazing with occasional cultivation. Structural soil conservation works such as absorption banks, diversion banks and contour ripping, together with the practices as in Class IV are required.*

Class VI land is *land suitable for grazing with no cultivation. Soil conservation practices including limitation of stock, broadcasting of seed and fertiliser, prevention of fire and destruction of vermin are required as may some isolated structural works.*

5.5.4.1 Agricultural Land Suitability Classification

Information supplied by NSW Department of Primary Industries [Agriculture] at Orange indicates that the Department has classified the some of the lands along the proposed flow line route using its agricultural land suitability system [Cunningham et al, undated; Hulme et al, 2002]. As with the land capability mapping, the lands within the Bibblewindi and Pilliga East State Forests have not been classified.

After field inspection during the soil survey, it is evident that, the NSW Department of Primary Industries [Agriculture] assessment of the agricultural land suitability of the Study Area is generally correct with most of the land Class 2 and 3.

5.5.5 Soil Management and Mitigation of Potential Impacts

Soil Stripping

Excessive handling of the materials during the stripping and windrowing operations and handling when the soils are wet would be avoided to protect any structure that may have developed. The stripping operation would be carried out using machines such as graders and bulldozers with angled blades.

Driving of machinery on the topsoil and subsoil windrows would be kept to an absolute minimum to maximise soil aggregation and prevent compaction, particularly when the stockpiles are moist.

Windrows may have to be protected from soil erosion in some places along the route and in sections of the trench that pass through drainage lines. These areas may need to have the windrow discontinuous to facilitate passage of water. In such instances it would be appropriate to breach the continuous windrow and push the material from the breached section into a slightly higher and wider windrow at each side of the breach. This would ensure that the material from the trench in the breached section is not taken too far from its source and place in an inappropriate section of the trench during rehabilitation.

Stripping / windrowing and trenching would not be allowed to progress too far in front of the pipe laying teams to reduce the amount of open trench and consequent potential for soil erosion.

Soil Conservation Measures

Measures would be taken to minimise loss of soil materials from the windrows, especially in the period before they are stabilised, e.g. using geo-textile "silt fences" or lines of straw / hay bales, small check banks etc.

Rehabilitation activities in the State Forest areas and areas containing remnant native vegetation would avoid the introduction of non native species. If stripping / windrowing and rehabilitation work is undertaken carefully and sloping sections of the rehabilitated route is suitably protected by soil conservation measures, the native seed in the topsoils should quickly re-establish cover.

On the open cleared agricultural land, the rehabilitated areas would be sown with suitable pasture / cereal species selected in conjunction with the individual landholders to achieve a rapid cover.

Other Mitigation Measures

The management of surface water runoff during the construction of the GGS and gas flow line remains an important consideration in preparing the environmental management plan. Prior to the commencement of construction, appropriate mitigation measures and safeguards would be implemented to would minimise the impact of sediment and silt mobilisation on and away from the corridor.

The strategy to limit the impacts of soils disturbance and the potential for surface water flows to mobilise soil and sediments away from the construction zone would include:

- the employment of temporary sediment control devices along the gas flow line corridor for the duration of the construction phase;
- the retention of groundcover vegetation along the margins of the gas flow line corridor;
- the protection of topsoils in areas not excavated to limit the exposure of subsoils to erosive mechanisms;
- the implementation of a stormwater management strategy to minimise runoff volumes and velocity across and around the construction zones;

- the replacement of cleared vegetation across the gas flow line corridor post construction to minimise erosive potential and maximise sediment capture. This strategy is in accordance with site rehabilitation practices devised in conjunction with Forestry NSW; and
- minimising soils disturbance by containing machinery and vehicular access to the gas flow line corridor and associated access tracks and forestry roads.

5.5.6 Assessment of Impacts

It is concluded that with the comparatively short construction period and the adoption of the soil management procedures and mitigation measures, the soil resources within the gas flow line corridor would be negligible.

5.6 Aboriginal Heritage

5.6.1 Introduction

The assessment of the potential, likely and actual impacts of the proposal on places and of Aboriginal heritage significance has been conducted with the assistance of the:

- The Pilliga Forest Aboriginal Management Committee (PFAMC) who represent the collective interests of the Aboriginal stakeholders for the Pilliga Forests including members of the Narrabri, Red Chief, Coonabarabran, Pilliga and Wee Waa Local Aboriginal Land Council.
- The Narrabri Local Aboriginal Land Council (NLALC) who represents the interests of traditional owners in the Narrabri area within which the northern section of the Project Site is located.

The Aboriginal heritage assessment for the Project is included in full as Part 5 of the *Specialist Consultant Studies Compendium*. The information in this section is summarised from that report.

The existing archaeological record is variable in its quality and accuracy for a number of reasons. Three sources of data have been consulted to provide a preliminary understanding of the extent of inhabitation of the Pilliga Outwash and the Narrabri area by the Gamilaroi people.

The collation of previous cultural heritage data including the Stage 1 & 2 Aboriginal Cultural Heritage Assessment for the Brigalow Belt Bioregional Assessment and current Aboriginal Heritage Registers provides the basis for the completion of field based surveying within the area of impact.

In terms of the Aboriginal heritage surveying, the DGRs specify:

"The Environmental Assessment must include an assessment of impacts on Aboriginal heritage, in accordance with draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation (DEC, 2005).'

5.6.2 Legislative Context

The legislation context for the protection and management of Aboriginal heritage in NSW is facilitated under the following.

- The *National Parks Act 1974* which provides statutory protection for all Aboriginal places and objects within NSW.
- The *Environmental Planning and Assessment Act 1979* which establishes a requirement for the formal assessment of Aboriginal heritage values in planning and development.
- The *Heritage Act 1977* provides statutory protection for items listed on the State Heritage Register and facilitates Interim Heritage Order protection for sites of potential heritage significance.

The proposed development is subject to the provisions within these legislative documents for the assessment of potential impacts of a development on Aboriginal heritage within the Project Site.

5.6.3 Consultation with the Aboriginal Community

The Proponent undertook a range of consultation programs involving notifications and advertisements of the development activity in the Narrabri Region in the following manner.

- The Project Site lies wholly within Petroleum Assessment Lease 2 (PAL2). In preparation for the assessment of this application to DPI (Mineral Resources) and pursuant to S29(4) of the *Native Title Act 1993 (Cwth)*, the Project Site was subject to advertisement in *The Australian* (12/07/05), *The Land* (16/07/5) and *The Narrabri Courier* (12/07/05).
- Representatives of Eastern Star have been in attendance at each Forestry NSW chaired PFAMC meeting over the past 3 year period which provided a mode of regular Project-related updates and acquisition of Aboriginal heritage advisory services and data.
- Eastern Star maintains regular contact with the Narrabri LALC for both Aboriginal heritage advisory services.

5.6.4 The Existing Environment

The Study Area falls within the traditional lands of the Gamilaraay/Gamilaroi Aboriginal Nation and within the boundaries of the Narrabri Local Aboriginal Land Council.

The southern section of the Project Site traverses light to moderately vegetated Crown Land within the boundary of the Pilliga East and Bibblewindi State Forests. The northern section of the Project Site traverses highly disturbed agricultural lands under ongoing seasonal cropping rotations and pasture improvement activities. The gas flow line corridor lies adjacent to existing fence lines and retained shelter belts and historical road easements.

5.6.5 Disturbance History Mapping

A review of the Disturbance History Mapping Project Report (RCAC, 2000) completed for the Western Regional Assessment indicates that the Pilliga East and Bibblewindi State Forests have been subject to disturbance regimes of varying types over a significant period. These disturbance events include various commercial forestry activities e.g. soft and hardwood products, gravels and other disturbances such as wildfires, grazing, mining and mineral / petroleum exploration.

As part of the Stage 1 Brigalow Belt South Bioregional Assessment, State Forests of NSW completed a disturbance history mapping project that aimed to consolidate the available information on the management history of the public forested lands in the Pilliga and Dubbo regions. Data was collated on the following types of disturbance regimes.

- Logging and silvicultural treatment.
- Prescribed burning and wildfire.
- Previous clearing.
- Regular grazing.
- Other relevant disturbances such as mining and mineral and gas exploration.

In terms of specific data collected for the Pilliga East State Forest, the mapping project indicates that a range of disturbances have impacted across large areas of the Project Site. The result of the Forestry Disturbance mapping project can be found in Appendix A of the Aboriginal Heritage Assessment. They indicate that the main disturbances have come from pre-1960's forestry products harvesting (saw logs, sleepers etc) and two major wildfires in 1951 and 1982 which impacted the entire Bohena CSG Project Area.

The southern section of the Project Site traverses moderately wooded and relatively undisturbed forestry compartments of the Bibblewindi and Pilliga East State Forest. Various sections of the gas flow line corridor intersect compartments previously selectively logged, vehicular access tracks receiving low to moderate frequency traffic, firebreaks of varying widths and areas subject to recent (<5 years) bushfires. The gas flow line corridor also intersects Bohena Creek approximately 2500m from the gas gathering system inlet hub at Bibblewindi-5 and an associated riparian zone approximately 150m wide which generally remains undisturbed.

5.6.6 The Archaeological Record

Existing sources of Aboriginal site records vary considerably in their quality and suitability for developing the predictive model. Three main sources were consulted recognising the extent of Aboriginal inhabitation across the larger Pilliga outwash and more specifically within the Project Site itself. They include the:

- National Parks and Wildlife Services Aboriginal Heritage Information Management System (AHIMS) database;

- Forestry/PFAMC site database; and
- Aboriginal Cultural Heritage Assessment – preliminary report (stage 1) Brigalow Belt South Bioregional Assessment (BBSB) (NSW NPWS – Western Directorate).

A search of the AHIMS database for sites and items of cultural heritage significance within the vicinity of the Project Site are illustrated in **Figure 5.11**.

Consultation with the Forestry NSW & PFAMC cultural sites database contains data collected across all survey efforts to date and indicates that a number of sites records exist within the vicinity of the Project Site and more specifically within 1000m of the gas flow line corridor. No illustrative representation of this data has been made available at the request of the PFAMC and Forestry NSW although this point data has been utilised in the preparation of the proposed gas flow line corridor.

The field surveying efforts for the Western Regional Assessment / Brigalow Belt South Bioregion generally comprised three parts, namely Aboriginal site surveying, landform mapping and recording native plants of Aboriginal significance. The aim of combining these information sources was to highlight the relationship between Aboriginal cultural heritage and landform categories.

In preparation for the cultural heritage assessment for the NSW Western Regional Assessments, a search of available databases for known sites of significance was carried out. A total of 145 sites of significance were recorded on that database.

The Aboriginal cultural heritage assessment for the Brigalow Belt South Bioregion, of which the Project Site is part, was the first State funded project to involve Aboriginal communities on such a large scale (RCAC, 2002). The cultural heritage assessment considered various facets of Aboriginal cultural heritage including Aboriginal sites and historical, social and spiritual association of areas within the Brigalow Belt South Bioregion.

As a result of the additional surveying effort, a further 116 sites of significance were identified. The results strongly indicate that Aboriginal sites occur in all landform categories identified and a relationship between Aboriginal sites and watered localities was established. **Figure 5.12** presents all 261 recorded sites within the Pilliga State Forests on the DECC Database and arising from the Western Regional Assessment.

5.6.7 The Predictive Model

In terms of the distribution and frequency of Aboriginal sites, Purcell (in RCAC, 2000) states that the location of Aboriginal sites reflects an affiliation with landform features that harboured a diversity of resources or were strategic to other landforms where resources could be accessed with a minimum of effort. Watered localities are the most common feature associated with the remains of Aboriginal Camps, which were situated with a radius suitable for accessing resources.

For the Project, the following predictive model was developed prior to the conduct of the field based survey component.

- Irrespective of the lack of permanent or semi-permanent water within the Project Site, the ephemeral creek lines and riparian zones posses a reasonable likelihood of containing places or items of significance. The survey effort would focus closely on the creek line itself and for up to 250m either side of the creek bank where natural depressions, elevated terraces and potential shelter may be identified.
- Scarred trees may be encountered on the margins of the ephemeral creeks where suitably mature (>100 years) individual may still exist.
- Although the lack of suitable rock outcrops reduces the likelihood of encountering quarry sites, grinding groves and associated open artefact scatters resulting from tool manufacture, maintenance etc, there is a possibility that exposed sandstones may be located.

5.6.8 Field Surveying

The main focus of the field-based survey effort for the cultural heritage assessment was the gas flow line corridor between the Bibblewindi CSG pilot and the Wilga Park Power Station running via the Bohena CSG pilot. The width of the disturbance within the flow line corridor would typically be approximately 10m and possibly less than 5m in width where existing access is available and prior disturbances have occurred.

No specific surveying was carried out on the cleared agricultural lands.

The survey effort in the southern, forested section of the Project Site was conducted by Mr. Eddie Trindall, cultural heritage officer representing the PFAMC, Mr. Matthew Trindall, trainee cultural heritage officer representing the PFAMC and Tim Donnan, Environmental Officer with Eastern Star Gas Limited. 100% of this section was surveyed on foot over a 2 day period.

5.6.9 Survey Results

The field based surveying effort identified one possible site of Aboriginal heritage significance; a scarred tree within the forested zone.

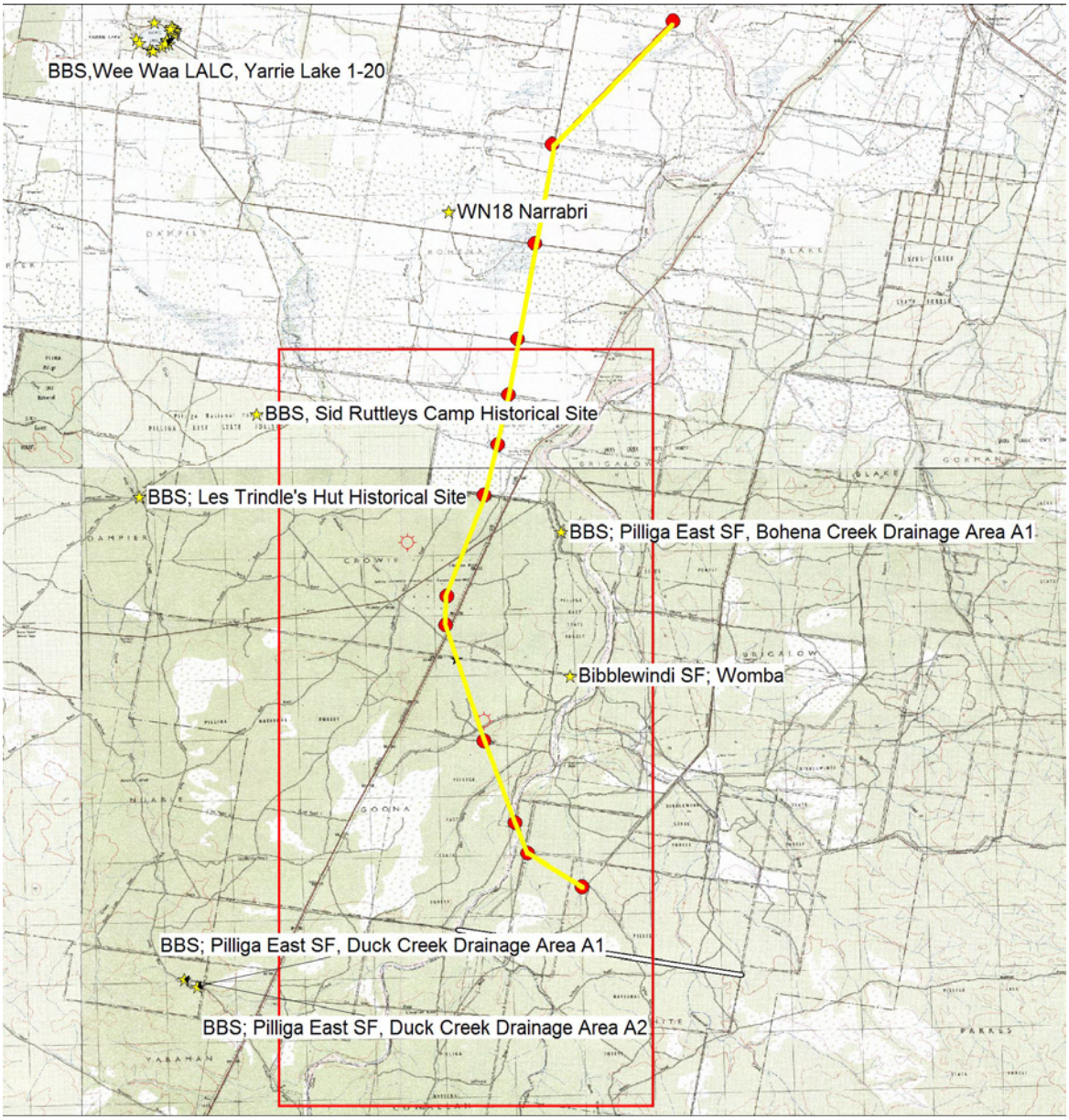


Figure 5.11
Aboriginal Heritage Recorded Sites

The scarred tree shown in **Plate 5.1** is located between Dog Fence Road and Pilliga Forest Way on the alluvial terrace between Bundock Creek and Bohena Creek. It does not lie within the gas flow line corridor. Within a lightly wooded section of the northern Pilliga East State Forest, the surrounding area is typical of the Narrow leafed Ironbark woodland common across the area. The area around this site has previously been impacted by some degree of clearing activity, most likely forestry operations targeting ironbark and white cypress as confirmed by the disturbance history mapping. This area has been subject to considerable disturbances from saw log, sleeper, firewood timber harvesting ion addition to the wildfires of 1951 and 1982. This individual Pilliga Box is one of less than 10 in the surrounding hectare of forest and has possibly been previously identified (but not recorded) and retained.

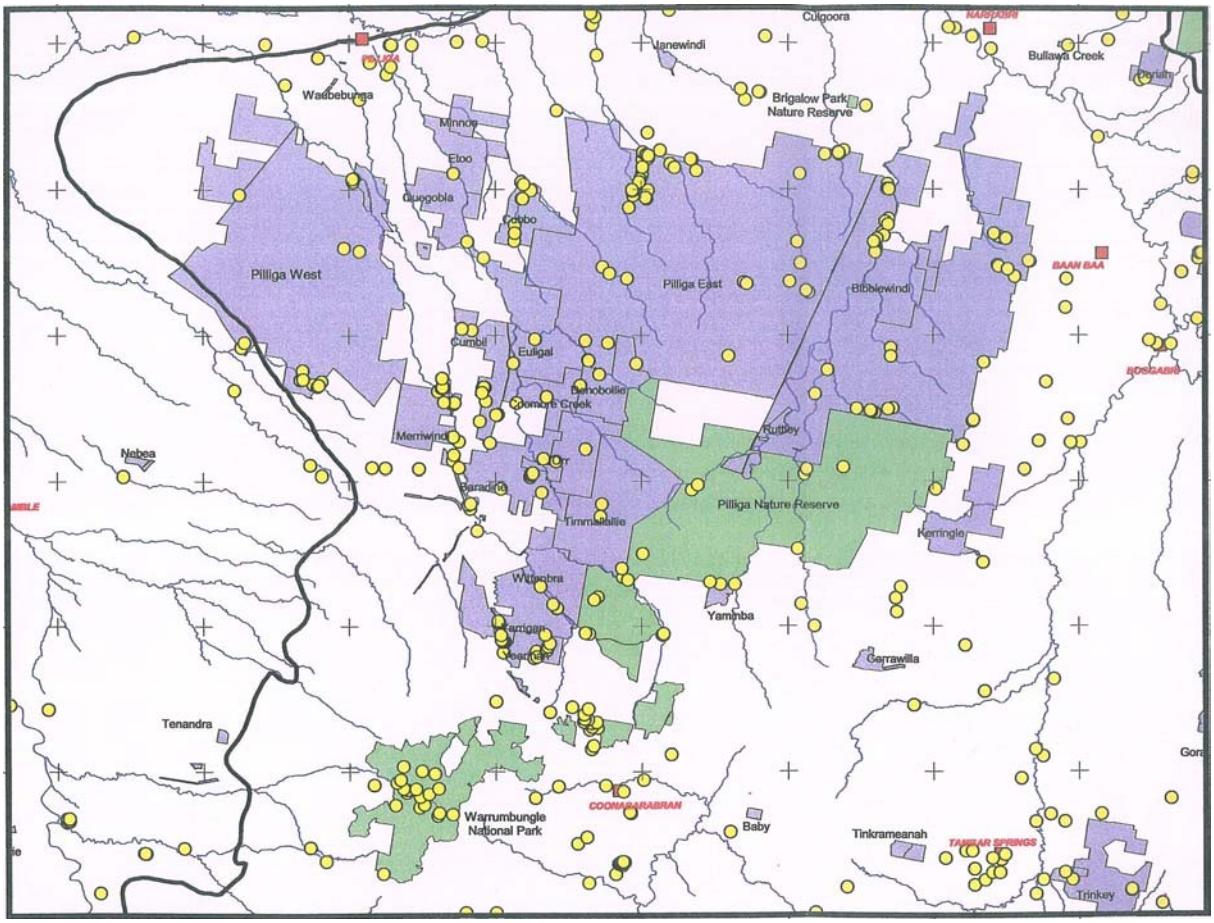


Figure 5.12
All Aboriginal Sites Recorded in the Pilliga State Forests

Plate 5.1
Scarred Tree Located Within the Vicinity of the Project Site

5.6.10 Discussion

The field surveying effort confirmed the main landform units within the gas flow line corridor are in order of occurrence from south to north.

- Sandstone hilly slopes.
- Mixed Ironbark/Bulloak/White Cypress forest on texture contrast soils (Humphreys et al in Dargavel, Hart and Libbis, 2001).
- Flat, mixed agricultural lands on cracking grey clays and fluvial soils.

The low number of sites identified during the survey for the Project is generally thought to be related to a range of environmental factors, primarily:

- a lack of permanent or semi-permanent water around which places (eg. campsites) of cultural significance may have been based;
- the lack of landforms such as rocky outcrop or exposed rocks that would have provided shelter and a potential materials resources;
- the lack of sufficiently mature old growth trees from which definite or possible scars could be located; and
- the frequency of bushfire across much of the Project Site and there impact on indigenous vegetation.

An additional factor affecting the potential for sites to be identified is the relatively narrow corridor of disturbance, significant disturbance pressures from forestry logging operations and the impact of historical instances of wild fires.

The preferred pipeline route has undergone assessment in terms of its likely and actual impacts on cultural significant sites through the following.

- Consultation with Forestry NSW Aboriginal sites database for known sites of significance within PAL2 provided to Eastern Star with the approval of the PFAMC. This data provided adequate justification for the placement of the preferred and alternate routes within the first 6km of its origin at Bohena-5. A minimum buffer zone of 500m is afforded to sites identified in this section.
- The completion of Aboriginal heritage surveying on the preferred route led by the recognised PFAMC heritage advisor (see Assessment Report included as Part 5 of the *Specialist Consultant Studies Compendium*).

The preferred route was selected and subsequently endorsed by Forestry/PFAMC as it observed an enlarged buffer zone (≈500m) around known archaeological sites where a landscape unit association could be identified. The type and frequency of sites in this area may be associated with the confluence of various tributaries, semi-permanent water, materials and tool manufacturing resources and the increased prevalence of Pilliga Box *Eucalyptus pilligaensis* and Red Gum *E. blakelyi* on which cultural scars are most often found.

The alternate route, although it made some use of an existing fire break did not observe a buffer zone of adequate size.

As further demonstration of the flexibility of design, the preferred route was adjusted again in the period post survey after the discovery of a possible cultural scar on a mature Pilliga Box (*E.pilligaensis*) north of the Bohena CSG Pilot.

The location of the possible scarred tree on the alluvial terraces/plains between Bundock Creek (2 300m west) and Bohena Creek (3 400m east) was generally unexpected. The area was dominated by narrow-leaf Ironbark open woodland and contained very few, scattered box (*Eucalyptus sp.)* that contain a high percentage of cultural scars. The possible scar on the *E. pilligaensis* identified in **Plate 5.1** was one of no more than 10 scattered individuals in this sparsely vegetated section of the gas flow line corridor. This area has been subject to logging operations over the past 60 years.

The proposed project would require the clearance of a 10m wide easement approximately 14km long within the northern Pilliga East State Forest. Due to the relative flexibility of the Project design, the likely impact of the activity on this site would be negligible. With a 30m exclusion zone surrounding this site, the gas flow line corridor would be moved to account for this site and no impact would be recorded.

This one remaining mature Pilliga Box and its possible cultural scar is a significant reminder of the past Aboriginal inhabitation, past use and occupation of the Pilliga Forests. Whilst no further sites were identified within the gas flow line corridor, the potential for additional places and sites of significance remains moderate and must be reflected in the recommendations and operations planning for the proposed development.

5.6.11 Mitigation of Potential Impacts

The potential Project-related impacts would be related directly to the destruction or modification of Aboriginal heritage sites or items of significance through the preparatory activities within the gas flow line corridor and the excavation of the trench that would accommodate the flow line.

The risk of impact on places or items of Aboriginal heritage significance within the Project Site can be mitigated to a significant degree through the development of site management safeguards that preserve the objectives of the cultural heritage survey. The Proponent would adopt the following recommendations proposed by the NLALC and PFAMC.

(i) The NLALC and PFAMC would be consulted if and when any changes are made to the approved project plans where heritage assessment activities are required.

(ii) Where changes are made to the project plans in regard to the surveyed gas flow line corridor, further field-based surveying would be carried out prior to any development activities commencing most specifically around the margins of Bohena Creek.

(iii) If any potential places, sites or items of cultural significance are identified, all activities would cease in the immediate vicinity of the site until such time as the appropriate representatives of the NLALC or PFAMC have assessed the site and adequate site management plans have been proposed.

(iv) The scarred tree identified in field surveying is marked and the proposed routes altered to account for the 30m exclusion zone.

It is also the Proponent's intention to engage the Cultural Heritage Officer with the Pilliga Forest Aboriginal Management Committee to undertake further surveys ahead of vegetation clearing and inspection of disturbed areas to confirm no Aboriginal heritage sites are disturbed during the construction / pipeline installation process. This commitment is re-iterated as Commitment 6.5 in **Table 6.1**.

5.7 Groundwater

5.7.1 Existing Environment

Data on the occurrence of groundwater beneath the Project Site is drawn from a groundwater impact assessment carried out Australasian Groundwater and Environmental Consultants Pty Ltd for a separate project within PAL2. The report provides background information only and the impact assessment and safeguards have been developed with the comparatively minor Project-related impacts.

Hydrogeological Regime

Three aquifer systems are present beneath the Project Site, namely alluvial aquifers, Pilliga Sandstone aquifers and Permian coal seam aquifers. Only the alluvial aquifers would be impacted upon by the Project.

Alluvial Aquifers

The alluvial aquifers within the Project Site are associated with Bohena and Bibblewindi Creeks, with minor thin veneers of alluvium in some tributary creeks. The alluvial sandy soil veneer does not form an aquifer except where Bohena Creek meets the major alluvial aquifer system associated with the deep paleo-channels of the Namoi River.

The alluvium of Bohena Creek and major tributaries consist of clean, medium to coarse quartz sands which are up to about 6m thick. The alluvial sands form elongated deposits confined to the creek alignment and have an estimated average width of about 60m along Bohena Creek. Lampert and Short (in AGE, 2006) describe the low sinuosity, fine grained river style typical of creeks in the area as having a relatively lateral stable channel due to the fine grained cohesive banks and floodplains.

The water table in the alluvium of Bohena Creek varies from surface level following periods of creek flow, to an estimated 2.0m below surface level during dryer periods. Natural water holes occur within the creek bed downstream of the discharge site, in areas of deep scour and where sand extraction has occurred. It is considered that groundwater in the alluvium is perched on the finer grained sedimentary deposits of the Blythesdale Group, as the water level in the deeper Pilliga Sandstone aquifer is 20m to 30m below ground level in the area.

Recharge of the alluvium occurs primarily from infiltration of surface water during creek flow events and to a lesser degree by direct infiltration of rainfall on the sand deposits. Groundwater flow is to the north along the creek channel, with discharge eventually to the Namoi River and/or the major alluvial aquifers associated with the river.

5.7.2 Potential Impacts

The potential Project-related impacts on the existing groundwater environment are limited due to the shallow depths at which the flow line is to be buried. The only potential impacts could occur within the groundwater present beneath the dry sandy surface of Bohena Creek.

5.7.3 Mitigation of Potential Impacts

The following safeguards would be adopted to protect the groundwater resources within the Bohena Creek area during the installation of the gas flow line.

- The natural erosion control offered by groundcover and mid stratum vegetation.
- When required, subsurface flows within the creek bed margins would be diverted around the gas flow line corridor by installing spear pumps upstream and pumping the water at least 200m downstream.
- Installation of silt meshing around the bank spoil to mitigate the risk of additional sediments entering the creek bed.
- Additional care would be taken when handling any hydrocarbons within and adjoining the Bohena Creek river banks so as not to cause any spillages.

5.7.4 Assessment of Impacts

The proposed range of safeguards outlined in this section would effectively mitigate all potential impacts on the groundwater resources within Bohena Creek. With the strict observance of these safeguards, the likelihood that the proposed activity would introduce any specific long term impacts on the quality or quantity of water for downstream users, the structural integrity of the creek banks and any indirect impacts on the ecological function of the creek is negligible.

5.8 Surface Water

5.8.1 Existing Environment

5.8.1.1 Regional Drainage

The Project Site lies within the Namoi River Basin Catchment, one of the main tributaries of the Barwon Darling River System. The Namoi River Basin covers an area of 43 000km^2 and incorporates the region's major centres of Tamworth, Gunnedah, Narrabri and Walgett (R.W. Corkery & Co. 2004). The Bohena Creek sub-catchment covers an area of 1 500km^2, and is the major drainage feature in the area. It is ephemeral in nature and flows only when significant rainfall occurs in the catchment.

5.8.1.2 Project Site Drainage

The Project Site is located within the Pilliga Outwash landscape unit as described in Lampert and Short (2004). An aggradational landscape of low lying, undulating alluvial sediments, the outwash is traversed by a number of south to northwest trending drainage lines. Most sediment within the streams of this landscape is derived from upstream Pilliga Sandstone plateaus or as a result of reworking of the broad outwash plain.

There are no permanent, natural flows within the Project Site. The largest feature, Bohena Creek is typical of the low sinuosity sand river style geomorphic unit summarised by Lampert and Short (2004).

5.8.2 Mitigation of Potential Impacts

The potential impacts of the Project on the existing surface water environment are limited due to the shallow depths at which the gas flow line would be buried and the intention not to cause any changes to the existing landform within the Project Site.

The likelihood of the project-related activities causing any measurable impacts on the natural drainage systems within the Project Site would be comparatively low. The intermittent flows observed within surface features and the methods of construction and flow line installation are designed to avoid any permanent modification of surface flows. The following safeguards have been developed with regard to the anticipated extent of disturbance resulting from the installation of the gas flow line.

- Minimising the extent of vegetation clearance within the corridor to enhance the natural erosion control offered by existing groundcover and mid stratum vegetation.
- Limiting vehicular and pedestrian traffic entering the creek beds, both overall and within the corridor so as to minimise incidental disturbance of creek bank.

- Installation of silt meshing around the bank spoil to mitigate the risk of additional sediments entering the creek bed.
- Commencing rehabilitation efforts on the creek bank section of the corridor as soon as practicable, making full use of the retained topsoils inherent regeneration potential.
- Monitoring the creek bank rehabilitation on a regular basis and initiating enhancement strategies, where required.

5.8.3 Assessment of Impacts

The proposed range of safeguards outlined in this section would permit the effective mitigation of potential impacts on the natural drainage features within the Project Site. With the strict observance of these safeguards, the likelihood that the Project would introduce any specific long term impacts on the quality or quantity of water for downstream users, the structural integrity of the creek banks and any indirect impacts on the ecological function of the creek is negligible.

The Project carries no measurable risk of altering the natural drainage systems along the gas flow line corridor nor increases the potential for any areas to be unnaturally inundated by flood water as a result of the construction or operation of gas transmission infrastructure. In these terms, the activities carried out to install the gas flow line do not alter any natural landforms or man made drainage infrastructure along the length of the Project Site. There is no near surface or above ground features within the corridor that could potentially divert or interfere with the existing drainage systems or cause any detrimental changes to the movement of surface water across the Project Site.

5.9 Noise

The text in this section is summarised from a noise impact assessment prepared by Spectrum Acoustics, a full copy of which is included as Part 6 of the *Specialist Consultant Studies Compendium*.

5.9.1 The Existing Acoustic Environment

The existing noise levels around the residences in the vicinity of the proposed gas flow line and Wilga Park Power Station are comparatively low given they are not currently experiencing significant industrial noise or high levels of traffic noise. The area is used predominantly for agricultural purposes and therefore is assumed to have background levels at or below 30 dB(A),L90 typical of a rural area. This background level would be adopted at all receivers for day, evening and night.

5.9.2 Potential Impacts and Assessment Criteria

Construction Noise

The following construction / installation works could potentially cause a noise impact at residences near the Project Site.

- Installation of the gas gathering system and gas flow line.
- Installation of additional generator sets at Wilga Park Power Station.
- Construction of additional switchyard equipment.

Recommended construction noise criteria vary depending on construction duration, as outlined in Section 157 of the DECC *Environmental Noise Control Manual* (ENCM) as follows.

- Construction period less than 4 weeks: L_{10} level restricted to background (L_{A90}) + 20dB(A).
- Construction period more than 4 weeks but less than 26 weeks: L_{10} level restricted to background (L_{A90}) + 10dB(A).
- For construction periods longer than 26 weeks, the operational noise criteria are assumed to apply.

DECC recommends construction during daytime hours only.

Installation of the gas flow line would progress at varying rates. Breaking the line down into 10km sections, the longest a section would be open is 15 days, at the very start of the section. This includes site preparation, pipeline installation and site cleanup. The midway point would be 7 to 8 days.
The installation of the gas flow line would therefore have the potential to impact on any receiver for less than four weeks and a criterion of 'background + 20dB(A)' or **50dB(A),L_{10}** applies.

Construction activities at the Wilga Park Power Station site are likely to be between four weeks and six months duration and a criterion of 'background + 10dB(A)' or **40dB(A),L_{10}** applies.

Operational Noise

In setting noise goals for a particular project, the Industrial Noise Policy considers both amenity and intrusiveness criteria. The former is set to limit continuing increase in noise from industry, whilst the latter is set to minimise the intrusive impact of a particular noise source. Given the receivers are not subject to significant existing industrial noise, the intrusiveness criteria are those applicable to setting the project specific noise goals. That is, the Rating Background Level (RBL) for the time period, plus 5dB(A). The Project-Specific Noise Levels (PSNL) for the Project is therefore **35dB(A) $L_{eq\ (15\ min)}$** day, evening and night.

Traffic Noise

In NSW, noise from vehicle movements associated with an industrial source is assessed in terms of the INP if the vehicles are not on a public road. If the vehicles are on a public road, the NSW Environmental Criteria for Road Traffic Noise (ECRTN) applies. Noise from the proposal must, therefore, be assessed against the project specific noise goals of the INP when on site and also the criteria in the ECRTN when travelling on public roads.

The ECRTN recommends various criteria based on the functional categories of roads applied by the Roads and Traffic Authority (RTA).

The RTA differentiates roads based on a number of factors including traffic volume, heavy vehicle use, through or local traffic, vehicle speeds and applicable traffic management options.

Vehicles accessing the site would do so via predominantly local roads as per definitions in the ECRTN.

Table 5.17 shows the noise criteria relevant to traffic on local roads extracted from Table 1 of the ECRTN. For the assessment of traffic noise, the day time period is from 7am to 10pm, whilst night is from 10pm to 7am.

Table 5.17
Road Traffic Noise Criteria

Situation	Recommended Criteria, $L_{eq(1\ hour)}$	
	Day (7am to 10pm)	**Night (10pm to 7am)**
13. Landuse developments with potential to create additional traffic on **local** roads	55 dB(A)	50 dB(A)

The ECRTN also advises that, where criteria are already exceeded:

"In all cases, traffic arising from the development should not lead to an increase in existing noise levels of more than 2 dB."

5.9.3 Mitigation of Potential Impacts

It is recognised that the activities involved during the installation of the gas flow line and expansion of the Wilga Park Power Station would involve comparatively low noise generating activities. Nevertheless, the Proponent would adopt the following mitigation measures to ensure surrounding residents are not impacted upon by noise.

- All earthmoving equipment used would be fitted with standard noise attenuation components and would be regularly serviced to avoid squeaks / rattles etc.
- Construction activities would only be undertaken during approved hours of operation.

5.9.4 Assessment of Impacts

5.9.4.1 Construction Noise

Spectrum Acoustics established that the sound power level of all equipment involved in the gas flow line installation would be 113dB(A). Based upon construction noise criterion of 50dB(A), the calculated noise level from gas flow line installation would satisfy the criterion at all residences greater than 160m from the gas flow line corridor. **Figure 5.5** shows the proposed gas flow line route and the location of the "Marooma" residence which is approximately 200m west of the gas flow line. This is beyond the 160m setback for potential noise impacts from construction activities. All other residences are located at greater distances from the gas flow line corridor.

The setback distance from the Wilga Park Power Station to achieve the 40dB(A) construction noise criterion would be 280m. The nearest residence ("Wilga Park") to the Wilga Park Power Station site is 850m to the southeast, hence no construction noise impacts are predicted.

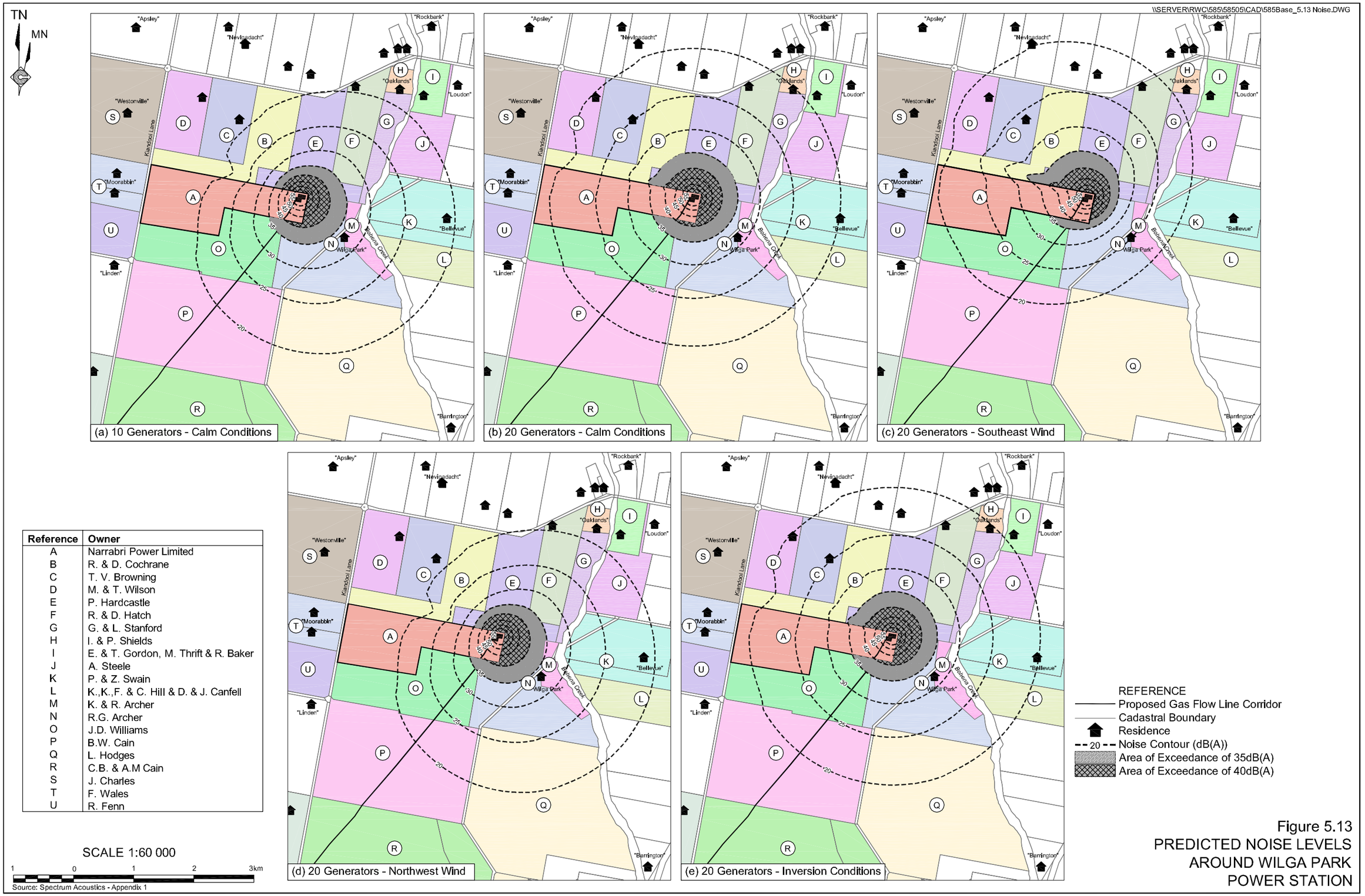
5.9.4.2 Operational Noise

The principal operational noise associated with the gas flow line would be associated with the gas compression facilities installed at both the Bibblewindi and Bohena CSG Pilots. Noise measurements taken on a comparable portable unit (a JIRO Model 8400) established that at a distance of 1 500m under calm conditions, the noise attributable to the compressor would be 27.1db(A) and 28.2dB(A) under a 5.0kph wind (see **Appendix 6C**). Given the closest residence to the locations of both compressor units would be "Burrawarna Park", no noise impacts would occur from the compression facilities as this residence is approximately 4.1km from the closest facility.

Noise levels of ≤20dB(A) are predicted at all residences surrounding the Wilga Park Power Station other than at "Wilga Park" under neutral and adverse meteorological conditions (see **Figure 5.13**). Noise at this level would rarely be detectable given background noise levels even at the quietest time are unlikely to fall below 25dB(A). The ENM predicted noise levels for the "Wilga Park" residence are shown in **Table 5.18.**

Table 5.18
Predicted Operational Noise Levels at "Wilga Park"

Predicted Operational Noise Levels dB(A), Leq (15 minutes) **with Generators Running at**	**Meteorological Condition**			
	Neutral	**Inversion**	**SE wind**	**NW wind**
3 units (part capacity)	23	25	<20	25
10 units (current full capacity)	28	30	22	30
20 units (future full capacity	34	34	27	35
Source: Modified from Spectrum Acoustics (2008) – Tables 3, 4 and 5				



Reference	Owner
A	Narrabri Power Limited
B	R. & D. Cochrane
C	T. V. Browning
D	M. & T. Wilson
E	P. Hardcastle
F	R. & D. Hatch
G	G. & L. Stanford
H	I. & P. Shields
I	E. & T. Gordon, M. Thrift & R. Baker
J	A. Steele
K	P. & Z. Swain
L	K.,K.,F. & C. Hill & D. & J. Canfell
M	K. & R. Archer
N	R.G. Archer
O	J.D. Williams
P	B.W. Cain
Q	L. Hodges
R	C.B. & A.M Cain
S	J. Charles
T	F. Wales
U	R. Fenn

Figure 5.13
PREDICTED NOISE LEVELS
AROUND WILGA PARK
POWER STATION

The predicted noise levels listed in **Table 5.18** confirm that under both neutral and adverse meteorological conditions, the noise attributable to the operation of the Wilga Park Power Station would comply with the operational noise criterion of 35dB(A) at all surrounding residences. Notwithstanding the predicted compliance, it is likely that the occupants of the "Wilga Park" residence could hear operations at the power station under adverse meteorological conditions.

The various contour figures included in **Figure 5.13** identifies that the 35dB(A) noise criteria would be confined to the property owned by Narrabri Power Limited and various, albeit comparatively small areas on five adjoining properties. **Table 5.19** lists the areas of the five adjoining properties that would experience noise levels >35dB(A) under the four nominated meteorological scenarios and the relative proportion that these areas form of the respective properties.

In the case of "Wilga Park" this is an established property and there would be no need for an additional residence on the western side of the property.

Table 5.19
Areas of Adjoining Land Where 35dB(A) is Exceeded

Ref.	Lot No.	Owner	Area of Land Where 35dB(A) is Exceeded ha (% of lot)			
			Calm	SE	NW	Inversion
B	1/1049313	R. & D. Cochrane	7 (5%)	13 (9%)	0	6 (4%)
E	2/1049313	P. Hardcastle	65 (43%)	58 (38%)	43 (28%)	66 (43%)
F	11/805987	R. & D. Hatch	2 (2%)	0	2 (2%)	4 (4%)
N	3/1064422	R. Archer	49 (50%)	21 (21%)	58 (59%)	51 (52%)
O	2/1064422	J. Williams	8 (4%)	4 (2%)	3 (2%)	6 (3%)

For the Hardcastle property to the north of the Wilga Park Power Station, the area of the property where noise levels experienced would exceed 35dB(A) is at the southern end of the property, ie. most distant from Yarrie Lake. Given the pattern of residential development on adjoining lots where the residences are generally positioned within 200m to 400m of the road (for ease of access / limited driveway length etc.) it is not anticipated any residence would be constructed within this area. Furthermore, it is noted that a considerable proportion of the land where the noise exceedances are predicted to occur contains considerable vegetation which is unlikely to be cleared to provide an area for a residence.

The areas of land on the three remaining properties where noise levels exceeding 35dB(A) may be experienced are comparatively small and typically less than 10% of the respective properties.

It is unlikely that for any of the areas on the five properties that would experience noise levels in excess of 35dB(A) would cause any adverse land use conflicts for the respective adjoining land owners. It is noted that the area of land that would experience noise levels in excess of 40dB(A) would be negligible.

5.9.4.3 Public Road Traffic Noise

Spectrum Acoustics (2008) predicted the maximum $L_{eq\ 1hour}$ noise level attributable to vehicles on public roads would be less than 40dB(A) at the closest residence to the public road network to be used by Project-related traffic. This is 10dB(A) below the criteria nominated in Section 5.9.2.

5.9.5 Monitoring

The Proponent would commission independent noise monitoring once the Wilga Park Power Station achieves the 40MW power generating capacity to demonstrate compliance with the predicted noise levels presented in Section 5.9.4.2.

5.10 Traffic Management

5.10.1 Introduction

The likely impacts posed by the Project on the flow of localised vehicular traffic are discussed in the following section. The scale of the Project, the operational environment and the existing roads infrastructure across the Project Site are likely to contribute positively to the cumulative impact on traffic flow and disruption for the duration of the construction period.

5.10.2 The Existing Environment

The proposed gas flow line corridor is well serviced along its entire length by a number of existing shire and forestry roads and private farm tracks. All access roads from the sealed Main Road network are unsealed and vary in terms of quality, overall condition and width. Main access and egress roads during construction would make use of Middle Road, Bohena Creek Road, Worombi Road, Plumb Road, Cherry Road (forested zone) and Dog Fence Road, Glenwood Lane, Yarrie Lake Road and Kiandool Lane (farmland zone). The Newell Highway bisects the southern section of the Project Site and would be utilised to provide access from the Narrabri township to the various shire roads and forestry tracks south of the forest edge.

The main access roads are generally utilised only by low volume local traffic. The Newell Highway is subject to comparatively high volumes of vehicular traffic including rigid, semi-trailer and articulated vehicles at all times of the day.

5.10.3 Potential Impacts

The potential impacts introduced on the shire and forestry roads during the construction period include:

- general damage to the road surface from increases in heavy traffic; and
- damage to the road surface and compacted base during periods of rainfall.

Daily vehicle movements are anticipated to be less than 30 per day for the duration of the construction period, with approximately 80% of these traffic movements at the beginning and end of the working day as contractors enter and exit the working area.

Whilst a majority of the vehicle movements are likely to consist of light 4WD and medium sized transport vehicles, the flow line materials would be delivered to staging areas along the route via semi trailers. The transport containers carry up to 500m of flow line material per load; the total number of semi trailers required to supply the Project with pipe would approximate 70 over the estimated 60 to 70 day construction period, ie. typically one or two loads per day.

At the completion of the construction phase, vehicular movements along the flow line easement are likely to average less than 6 per week.

5.10.4 Mitigation of Potential Impacts

The mitigation of the impacts associated with increases in traffic during the construction period would be achieved to a significant extent through the implementation of a specific traffic management plan that includes:

- minimisation of over-length and over-sized traffic on smaller access tracks;
- minimising the need for vehicle turn-around; and
- a dust suppression program for all access and egress pathways during high volume periods.

During the construction period, the Proponent would contact the landowners to inform them about the program and use of local roads and tracks.

5.10.5 Assessment of Impacts

In the event damage is caused to any road or access track, remediation of damage would occur as soon as practicable to a level considered satisfactory to Forestry NSW representatives or Narrabri Shire's designated supervisor for these matters.

The proposed strategy to mitigate the potential impacts of the increased traffic volumes along the flow line route would focus on the minimisation of disruption to localised traffic flows and to mitigate the increased risk of road damage caused by higher frequency traffic on unsealed roads.

In general terms, the disruption to localised traffic flows within the Pilliga East and Bibblewindi State Forests is expected to be low to very low. The forested area does not receive any significant daily traffic flows that could be impacted by the Project. The extensive system of high quality forestry roads and tracks would permit the safe and efficient flow of traffic into and out of the working area without any need for alteration to their current condition (ie. width or road base quality) or the installation of vehicle turnarounds. Coupled with the proposed dust suppression program, the likelihood of any significant issue in terms of traffic flows or damage to existing infrastructure is low. The management of traffic within State Forest Land would occur in accordance with relevant guidelines provided by Forestry NSW for gas exploration activities.

In the open farmland environment (northern section of the gas flow line corridor), the shire roads are subject to low to medium levels of mostly residential traffic movements, a majority of which occur in the morning and afternoon. For approximately 95% of the construction period, the working area would be located well off any access or egress pathway in areas subject to localised traffic movements.

Where the working area intersects a Shire road and a sub-surface crossing is required, the Proponent shall implement a suitable traffic control plan as directed by Council in accordance with the RTA's Traffic Control at Worksites guidelines that accompany the Proponents *Application for Flow lines Under Various Shire Roads* (see **Appendix 4**).

5.11 Visual Amenity

5.11.1 Introduction

The preliminary risk assessment carried out for the Project suggested that the potential for the proposal to create long term visual impacts across the Project Site varies considerably across the construction phases through to post rehabilitation.

The risk rating derived for the main components of the proposal include:

- reduced visual amenity of the Project Site as a result of:
    a. temporary removal or modification of vegetation along the flow line route (high/moderate);
    b. long term visual impacts along flow line route from removal/modification of vegetation (low); and
    c. placement of flow line markers along the full length of the easement (low).

5.11.2 The Existing Environment

The existing environment presents two distinct visual environments across the Project Site.

- The Vegetated Forest Zone

  Varying from lightly to heavily vegetated, the removal and modification of vegetation along the flow line route presents a high to moderate risk of short to medium term visual impacts.

- Open Farmland

  Varying from highly disturbed and cleared grazing/cropping paddocks to isolated clumps/shelter belts consisting of native vegetation, the installation of the flow line across this environment presents a low risk to the visual amenity of the area.

5.11.3 Potential Impacts

The proposal requires clearing a 10m wide corridor linking the Bibblewindi CSG pilot and the Wilga Park Power Station. In terms of visual impact, this would require the removal of most of the vegetation within the 10m wide corridor for the length of the flow line that:

(a) occurs within the forested zone; and

(b) cannot make use of existing roads and access tracks; or

(c) is located upon the cleared lands but still requires some modification or removal of vegetation *in situ*.

All equipment used during the installation of the gas flow line would be clearly visible in the open farmland, albeit for a comparatively short period.

At the completion of the gas flow line installation, the rehabilitation of approximately 7m of the corridor would reduce the medium to long term visual impacts to a significant degree.
The maintenance of approximately 3m of the corridor in a vegetation free state is required for the Project's operational life. This cleared area would provide ongoing access for gas flow line maintenance in addition to reducing the potential impact of bushfire in the close vicinity of the buried gas flow line. This retained area would be maintained for the duration of the Project's operational life.

The installation of buried flow line markers at 250m intervals and/or where it passes below fence lines, roads and other utilities is unlikely to result in any significant visual impact across the Project Site.

5.11.4 Mitigation of Potential Impacts

Based upon the potential impacts discussed in Section 5.11.3, the specific mitigation strategy to reduce the impact of the proposal on the visual amenity of the areas surrounding the Project Site would focus on the rehabilitation of vegetation removed or modified in preparation of the flow line easement.

At the completion of trench backfilling and compaction, the respreading of stockpiled topsoils would mark the commencement of the rehabilitation phase. The corridor would be reduced in width from 10m to the 3m required for ongoing access and maintenance by initially replacing any felled material back across the corridor ('brushing') to encourage initial soil stabilisation and the regrowth of successional species. The retained corridor would be kept devoid of all hardwood species for the Project's life. It is projected that the reduction in size and the rehabilitation of the easement would mitigate the visual impact across the variable landscapes to a significant degree.

Any variation to the full rehabilitation of the easement and retained access tracks would occur when a landholder requests it retention (e.g. for continued on farm access), particularly as most are located along existing fence lines and may provide additional benefit to the landholder.

Apart from the mitigation of the impacts associated with vegetation clearing, the Proponent would ensure that the work sites along the entire gas flow line corridor are kept tidy at all times.

5.11.5 Assessment of Impacts

The short to long term impacts on the visual amenity of the Project Site are considered finite and have been well characterised. The creation of the 10m wide corridor through the forested section represents the greatest visual impact requiring assessment whereas the creation of the variable width corridor on the freehold agricultural lands poses a significantly lesser issue in these terms.

The opportunity to reduce the visual impact of the corridor within the forested lands is generally limited, however, in reality, it would be comparable with the existing tracks created through the State Forests. There is an inextricable link between the width of the corridor and the proposed rehabilitation strategy that upon further analysis is inflexible in presenting any real mitigation potential. This link relates to the area required to retain the vegetation on the edge of the ROW that is to be utilised in the rehabilitation of the 7m area not retained post construction.

It is the opinion of the Proponent that the 10m corridor and the visual impacts created by the vegetation clearing during the construction of the flow line cannot be avoided and that the proposed rehabilitation program proposed would permit the regeneration of ground cover and mid storey native species in an acceptable period after construction activities have ceased (ie. within 3 to 5 years). The operating environment itself plays a large role in the success of rehabilitation and as such climatic conditions year to year would play an integral part in the natural regeneration of the corridor.

Throughout the construction period, the equipment involved would be visible mainly from within those rural properties being traversed or from adjoining properties. The equipment would be comparable with equipment used in road maintenance and only on site for a comparably short period. Hence, the overall impact would be minor.

The marking of the flow line route with adequate locational and safety signage is a key requirement that cannot be avoided. Australian Standard 2885 is the overarching standard that applies to the operation of flow lines in excess of 1050kPa. The erection of signs indicating the location of the flow line must occur frequently and at various points along the route at intervals not exceeding 500m. No deviation from these standards can be expected and hence any visual impact from the placement of the signage cannot be mitigated.

5.12 European Heritage

5.12.1 Introduction

A desktop search for all listed heritage sites within the Narrabri Local Government Area was completed across the available State and Commonwealth site registers. They include:

- the Narrabri Local Environment Plan 1992;
- the Australian Heritage Database (http://www.environment.gov.au/heritage/ahdb/) which includes places listed in the World Heritage List, the National Heritage List, the Commonwealth Heritage list and the Register of the National Estate);
- State Heritage Register; and

- State Heritage Inventory.

The results of an online search of the Australian Heritage Database are reproduced as follows.

Australian Heritage Database

Search Results

edit search | new search | about the Australian Heritage Database | Heritage home | Australian Heritage Council home

8 results found.

Collins Park Grandstand Tibbereena St	Narrabri, NSW, Australia	(Indicative Place) Register of the National Estate
Indigenous Place	Bullawa Creek, NSW, Australia	(Registered) Register of the National Estate
Mount Kaputar National Park Narrabri Bingara Rd	Narrabri, NSW, Australia	(Registered) Register of the National Estate
Narrabri Gaol (former) Barwan St	Narrabri, NSW, Australia	(Registered) Register of the National Estate
Narrabri Post Office and former Telegraph Office 138-140 Maitland St	Narrabri, NSW, Australia	(Registered) Register of the National Estate
Narrabri Post Office and former Telegraph Office 138-140 Maitland St	Narrabri, NSW, Australia	(Indicative Place) Commonwealth Heritage List
Narrabri Public School 90 Barwan St	Narrabri, NSW, Australia	(Registered) Register of the National Estate
Police Residence 50 Maitland St	Narrabri, NSW, Australia	(Registered) Register of the National Estate

Report Produced: Wed May 16 16:50:14 2007

5.12.2 The Existing Environment

No heritage sites were listed as occurring within the Project Site, with the majority of the registered items being found within the Narrabri Township. The Indigenous Place listing for Bullawa Creek refers to a site located within the boundary of the Mount Kaputar National Park, to which the Project carries no risk of interference.

A visual inspection of the proposed route for sites of European heritage significance was carried out during the Aboriginal heritage surveying. No sites or items of European heritage significance were located along the gas flow line corridor.

5.12.3 Potential Impacts

With no identified sites of heritage importance located within the Project Site, the proposed development carries no risk of impacting on known heritage sites within the Narrabri local government area.

5.12.4 Mitigation of Potential Impacts

No mitigation strategy is required for the protection of any recorded heritage sites within the Project Site.

If any potential places, sites or items of potential European heritage significance are identified during the construction process, all activities would cease in the immediate area of the site until such time as the appropriate representatives from Forestry NSW, the Narrabri Shire Council or an alternative authority has assessed the site and adequate site management plans have been devised.

5.12.5 Assessment of Impacts

Given no identified sites of European heritage significance are known to occur within the gas flow line corridor, no adverse impacts are expected to occur.

5.13 Hazards and Risks

5.13.1 Introduction

Based upon the description of the Project components throughout Section 3 of this document and the range of design and operational safeguards throughout this section, it is possible to review the various hazards and residual risks attributed to the Project, as described. The contents of this section are drawn largely from the text in **Appendix 3** and specific notes compiled by the Proponent relating to safety issues involving the gas flow line and components of the Wilga Park Power Station.

5.13.2 Hazardous Materials – Wilga Park Power Station

The hazards and risks posed by the storage, use and / or spillage of the three following potential hazardous materials on site would be negligible.

- Q8 Mahler MA Lubricating Oil (maximum 20 000 litres stored on site).
- Cummins DC44 Coolant Additive (maximum 205 litres stored on site).
- Caltex XL Corrosion Inhibitor (maximum 600litres stored on site).

These materials are contained within appropriate enclosures, either the internal storage facility within the workshop (coolant additives) or the bunded oil store. Approved spill kits are available on site to manage any spills. It is further noted that all three products are not classified as dangerous goods under the *Australian Code for Transportation of Dangerous Goods by Road and Rail*.

5.13.3 Operational Risks – Gas Flow Line

Table 5.20 summarises the main hazards and risks relating to the operation of the gas flow line. These hazards, discussed in detail in **Appendix 3** reflect the activity itself and the features of the local environment where the gas flow line will be placed. It is noted that the consequences for each threat / hazard were considered from public, employee, environmental and economic perspectives and take into account the mitigation strategies incorporated into project design, construction and operations planning.

Table 5.20
Summary of Hazards and Risks – Gas Flow Line

Threat / Hazard	Frequency	Consequence	Risk Ranking
Third Party Interference	Unlikely	Severe	Low
Fracture of Flow Line	Remote	Severe	Low
Overpressure of Flow Line	Improbable	Minor	Low
Escape of Flammable Contents	Remote	Severe	Low
Pipe Exposure at Road Crossing	Improbable	Minor	Low
Pipe Exposure at Creek Crossing	Improbable	Minor	Low
Source: Appendix 3 (as modified)			

The Proponent also reviewed the risks associated with the integrity of the gas flow line itself noting that adoption of all complying requirements in the relevant Australian and International standards would ensure that no inappropriate risks would occur. The pipeline integrity was also an important factor in recognising that the risk of bushfire from a leak / vent of gas will be negligible. Further details of the technical aspects of the GRE pipe to be used and the safeguards to be adopted to retain a low fire risk are outlined in **Appendix 3.**

5.13.4 Assessment of Offensiveness

Appendix 3 also presents an assessment of whether the Project is potentially offensive. In brief, the Proponent is confident that the Project does not constitute potentially offensive development as the air emissions arising from extraction and combustion of the CSG will be within the nominated emission limits. The use of the most advanced electricity generation systems will achieve best practice in emissions control.

Furthermore, the CSG produced and transported via the gas gathering system and gas flow line is odourless and poses no measurable likeness of impacting on the environment at its origin or destination or on any receptor within the boundary of the Project Site.

5.13.5 Conclusion

The residual environmental risks arising from the use of the gas flow line and the Wilga Park Power Station are considered to be low. Hence, a preliminary hazard analysis relating to the Project is not required.

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